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ANNALS
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Volume 45 SEPTEMBER 1952 No. 3

In Memoriam

CLARENCE HAMILTON KENNEDY, A.B., A.M., Ph.D., D.Sc.
1879 – 1952

Clarence Hamilton Kennedy

Clarence Hamilton Kennedy was born June 25, 1879, at Rockport, Indiana, and died at Columbus, Ohio, June 6, 1952.

He studied at Oberlin College for one year and then at Indiana State University where he received the A.B. degree in 1902, the A.M. in 1903 and the D.Sc. in 1950. He was an assistant in zoology in 1902 and 1903. He received an A.M. degree at Stanford University in 1915. At Cornell University he received the Ph.D. degree in 1919. While at Cornell he was an assistant in biology in 1915 and instructor in limnology 1916–17. He was an assistant in the Bureau of Fisheries as a scientific artist of sea fishes and was a botany collector in Texas and Oregon for Mt. Holyoke College Herbarium. He was an instructor in zoology at North Carolina State Agricultural College 1918–19 and also at Ohio State University 1919–21 and Assistant Professor there 1921–30; Associate Professor 1930–33; Professor of Entomology till his retirement at age of 70, and Professor Emeritus till his death.

In an article in the *Graduate School Record* of Ohio State University entitled, "What is Research and How is it Developed?" he says, "My first interest was that of the toads of the woods. By four or five years of age I gathered swamp sedges and flowers. I learned about crayfish, and owl nests. I watched the great flocks of blackbirds in the forest top, the redwings in the stream bottoms, the rabbits in early morning under the trees. I collected butterflies with a frayed straw hat and pinned them on certain permitted areas of the walls of the sitting room.

"Five years of poor health followed Indiana State University, but with improved health my craving for university work took me to Stanford University. There I interviewed Vernon Kellogg with whom the most delightful year of my life ensued. He looked over my manuscripts on Washington and Oregon dragonflies and remarked, 'You are an entomologist already. I am signing you up for a Master's degree. Your paper on the dragonflies of Washington and Oregon, already finished, will be your M.A. thesis.' What courses? 'Keep on with your research on dragonflies.' Barton Warren Everman, Director of the Museum of the California Academy of Science, procured passes for me over the railroads of California and Nevada where I collected natural history specimens and was footloose for dragonflies. When low on money I fell back on my ability at illustrations of fish, birds and insects.

"Kellogg was an idealist and a gentleman. He would wander into my cubbyhole and talk for two and three hours at a time. My years of discouragement vanished. 'There is one right attitude or solution. Find it and follow it.' He repeated my father's instructions, 'Associate with honesty and idealism.' My father, E. B. Williamson and Kellogg placed my levels of idealism in research.

"On reviewing my list of publications I find 116 articles, one a widely sold mimeographed book on the internal anatomy of insects (my specialty in teaching), one on Indiana archaeology, 8 on birds (mostly western), 9 on ants, 4 on fish with Carl E. Eigenmann as co-author, 57 on dragonflies which are my extensive works with perhaps 2000 of my drawings as illustrations, 15 miscellaneous papers on general biological theory, addresses at meetings, and so on."

As Managing Editor of the Annals of the Entomological Society of America Doctor Kennedy became one of the distinguished scientists of America. He was Managing Editor from 1929 to 1945 (President 1935), also a member of the Association of Economic Entomologists; the Society of Naturalists; Ecological Society; Fellow Ohio Academy of Science, vice-president of section of zoology in 1926 and 1927; Indiana Academy of Science; Fellow, A.A.A.S.; Royal Entomological Society of London; Societé Entomologique de France, and Sigma Xi (president Ohio chapter 1926–27). His specialties have been morphology and ecology of insects, Odonata and Ants.

In the December, 1949, number of the *Buckeye*, Columbus Entomological Society, there is a portrait of him and a "Dedication" to his retirement and a poem by Doctor R. C. Osburn.

He was the son of Albert and Emma (Tennant) Kennedy. He married Lydia June Findley March 16, 1927. The children are Bruce Albert Hamilton and Mary Janet.

His portrait appeared in *Fragments of Entomological History*, Part I, Plate 31. Mrs. Kennedy has put in my hands the services at the funeral which were impressive and very appropriate for a man of his stature but space does not permit extended remark or quotation.

HERBERT OSBORN.

SIX NEW NEOTROPICAL SPECIES OF CULICOIDES
(Diptera: Ceratopogonidae)

IRVING FOX
School of Tropical Medicine
San Juan, Puerto Rico

Types of the new species described below are in the entomological collection of the Department of Microbiology, School of Medicine, School of Tropical Medicine, San Juan, Puerto Rico.

Culicoides caprilesi, new species

Fig. 1

Female.—About 1.4 mm. long. Eyes widely separated, no seta on the frons between them (fig. 1, D). Labrum very short, 0.123 mm. in length, ratio of labrum to clypeus plus frons 44:67. Antenna with segments 3–13 of about the same length, segment 14 slightly longer and wider (fig. 1, F). Palpus slightly longer than the labrum, with the third segment slightly longer than the second and wider with a distinct round sensory pit, fourth segment wider and shorter than the fifth (fig. 1, A). Mesonotal pattern unknown. Legs light brown, tibiae with basal light rings; hind tibial comb with four equidistant robust bristles of which the first is longer than the others (fig. 1, C). Wing 0.86 by 0.38 mm., with sparse macrotrichia; vestigial second radial cell long and slanting, in a dark spot. Following the wide dark spot over the costal cell there are four light spots anteriorly, one over the cross-vein which is more or less hour-glass shaped, one below the second radial cell, one adjacent to the tip of the second radial cell which is small and round and a large one in the form of an inverted U in the distal portion of cell R_5; cell M_1 with two light spots; cell M_2 with one distinct round light spot distally, but basally there is a wide light area; cell Cu_1 and anal cell with a single light spot each (fig. 1, B). Spermathecae double, oval, the ducts sclerotized for a short distance (fig. 1, E).

Type Material.—Female *holotype* collected by Prof. Jenaro Maldonado Capriles at Mount Marahuaca, Venezuela, on May 2, 1950.

Remarks.—This species appears to be similar to the briefly described *C. pachymerus* Lutz, differing particularly in the shape of the most distal pale spot in cell R_5 of the wing. In regard to this new species and the following one, *C. obnoxius*, Prof. Maldonado writes, "Place of collection: tundra north of Marahuaca Mountain, Pacaraima Range, Territorio Amazonas, Venezuela, South America. Elevation 4,050 feet. May 2, 1950, during University of Puerto Rico expedition to the named place. Biting collector's arm at 6:00 P. M., before sunset. Attack lasted about 30 minutes and then completely subsided. Attack of these biting midges was noticed during days with sporadic rainfall. After the rains started they were not noticed again."

Culicoides obnoxius, new species

Fig. 2

Female.—About 1.2 mm. long. Eyes widely separated, a conspicuous seta on the frons between them (fig. 2, D). Labrum very short, 0.120 mm. in length, ratio of labrum to clypeus plus frons 43:56. Antenna with segments 3–5 more or less bead-like, 6–9 somewhat longer, 10–13 about equal in length, much longer than the others (fig. 2, E), segment 14 damaged in preparation. Palpus shorter than the labrum, about 0.106 mm. in length, with the third segment massive bearing a large sensory pit, fourth segment much wider than the fifth (fig. 2, A). Mesonotal pattern unknown. Legs brown, middle femora with distal light rings and all the tibiae with basal ones; hind tibial comb consisting of four equidistant robust bristles of which the first is longer than the others (fig. 2, B). Wing 0.84 by 0.36 mm. with very few macrotrichia; vestigial second radial cell very long and slanting, its tip included in a light spot, but the rest in a dark spot. Following the more or less triangular dark spot over the costal cell there are three light spots anteriorly, one over the cross-vein which posteriorly is confluent with the basal light spot of cell M_2 and two in cell R_5 of which the apical one reaches to the anterior edge of the wing being "open"; cells M_1 and M_2 with two light spots each; cell Cu_1 with a large light spot which reaches to vein Cu_1; anal cell with a single light spot (fig. 2, C). Spermathecae double, oval, the ducts sclerotized for a short distance, similar in size and shape to those of *C. caprilesi*.

Type Material.—Female *holotype* collected by Prof. Jenaro Maldonado Capriles at Mount Marahuaca, Venezuela, on May 2, 1950, while biting.

Remarks.—This species is similar to *C. caprilesi* but differs in the wing pattern and the structure of the antenna and palpus as well as in having a seta on the frons between the eyes.

Culicoides efferus, new species

Fig. 3

Female.—About 1.6 mm. long. Eyes contiguous. Labrum very long, 0.336 mm. in length, ratio of labrum to the distance from the labrum to the lower point where the eyes join 120:75. Antenna with segments 3–9 about the same length and shape, segments 10–14 larger (fig. 3, E). Palpus about as long as the labrum, second segment long and broad, third segment only slightly longer and broader than the second with a small shallow sensory pit, fourth and fifth segments about equal in length (fig. 3, A). Mesonotal pattern unknown. Legs uniform light brown, hind tibial comb with six robust bristles of which the second and third are the longest (fig. 3, B). Wing 1.46 by 0.67 mm. with very few macrotrichia, a species of the *pulicaris* group the second radial cell is in a light spot. In addition to the dark distal portion of cell R_5 there are three conspicuous dark spots anteriorly, a rather narrow triangular one over the costal cell, one at the junction of the radial cells which is continued below them to vein M_1 and a narrow one not hour-glass shape beyond the second radial cell which is followed by a light spot, these dark spots are interrupted below vein M_1 and continue

again thereafter as shown in fig. 3, C. Spermathecae double, globular, the ducts sclerotized for a short distance (fig. 3, D).

Type Material.—Female *holotype* from Rio Charape, Peru, collected by C. H. T. Townsend, Sept. 14, 1911.

Remarks.—This species is similar to *C. elutus* Macfie from which it differs in the wing pattern; in particular the dark spot in cell R_5 is not hour-glass shaped and the light spot which follows it does not, as in *C. elutus*, occupy the tip of the wing.

Culicoides beebei, new species

Fig. 4

Female.—About 1.6 mm. long. Eyes contiguous. Labrum short, 0.182 mm. in length, ratio of labrum to the distance from the labrum to the lower point where the eyes join 68:58. Antenna with segments 3–5 equal in length and similar in shape, 6–9 slightly longer, 10 and 11 still longer, 12–14 missing. Palpus longer than the labrum, 0.204 mm. in length, third segment longer than the first and second, broadly expanded with two sensory pits, fourth segment broader and shorter than the fifth (fig. 4, A). Mesonotal pattern unknown. Legs, brown, lighter at the junctions of the femora with the tibiae; hind tibial comb with six robust bristles of which the second and third are the longest (fig. 4, B). Wing 1.21 by 0.47 mm. with few macrotrichia, a species of the *pulicaris* group the second radial cell is in a light spot. In addition to the dark distal portion of cell R_5 there are three dark spots anteriorly, which are continued posteriorly as shown in fig. 4, C. Of particular interest is a wide dark spot over the base of vein M_2 followed by a light spot which straddles the latter; cells M_1 and M_2 with a distal light spot each; cell Cu_1 with a large light spot that reaches to Vein Cu_1; anal cell with a large light spot in the form of an hour-glass. Spermathecae double, large, globular, the ducts sclerotized for a short distance (fig. 4, D).

Type material.—Female *holotype* from Rancho Grande, 3600 ft., north-central Venezuela, between Maracay and Caribbean, collected by Dr. William Beebe, August 1, 1946.

Remarks.—This species is similar to *C. luteovenus* Root and Hoffman from which it differs in having fewer macrotrichia on the wing, a much more narrow dark spot over the costal cell, and a wide dark spot over the base of vein M_2.

Culicoides ortizi, new species

Fig. 5

Female.—About 1.3 mm. long. Eyes contiguous. Labrum short, 0.146 mm. in length, ratio of labrum to the distance from the labrum to the lower point where the eyes join 52:50. Antenna with segments 2–9 bead-like thereafter, abruptly changing in shape (fig. 5, E). Palpus longer than the labrum, 0.168 mm. in length, third segment slightly longer than the first and second, broadly expanded with a large sensory pit, fourth segment broader and shorter than the fifth (fig. 5, A). Mesonotal pattern unknown. Legs yellowish brown, light rings distinct on fore and mid femora distally, and basally on all tibiae;

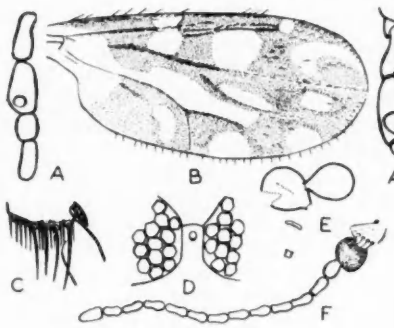

FIG. 1 CAPRILESI

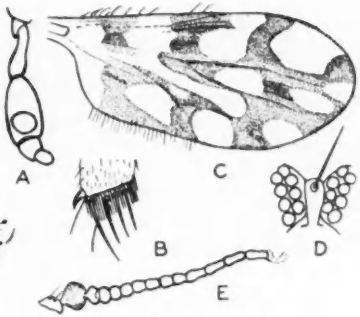

FIG. 2. OBNOXIUS

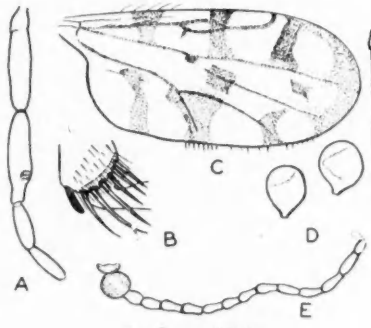

FIG. 3. EFFERUS

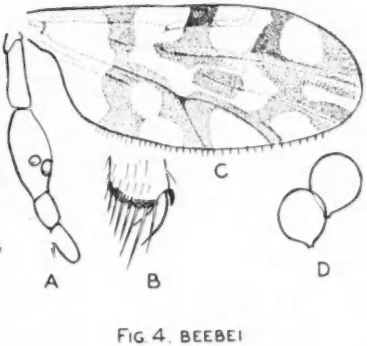

FIG. 4. BEEBEI

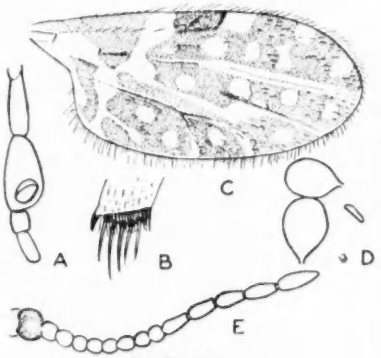

FIG. 5 ORTIZI

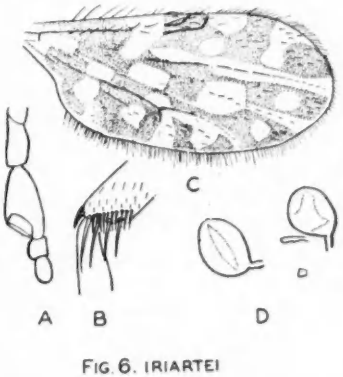

FIG. 6. IRIARTEI

FIG. 1. *Culicoides caprilesi*, new species, female; A, palpus; B, wing; C, hind tibial comb; D, eyes; E, spermathecae; F, antenna. FIG. 2. *Culicoides obnoxius*, new species, female; A, palpus; B, hind tibial comb; C, wing; D, eyes; E, antenna. FIG. 3. *Culicoides efferus*, new species, female; A, palpus; B, hind tibial comb; C, wing; D, spermathecae; E, antenna. FIG. 4. *Culicoides beebei*, new species, female; A, palpus; B, hind tibial comb; C, wing; D, spermathecae. FIG. 5. *Culicoides ortizi*, new species, female; A, palpus; B, hind tibial comb; C, wing; D, spermathecae; E, antenna. FIG. 6. *Culicoides iriartei*, new species, female; A, palpus; B, hind tibial comb; C, wing; D, spermathecae.

hind tibial comb with five robust bristles of which the second is the longest (fig. 5, B). Wing 1.01 by 0.43 mm., with abundant macrotrichia; second radial cell in a dark spot. Cell R_5 with six light spots arranged in two triangles; cell M_1 with three light spots which follow a round light spot in the middle of the wing; cell M_2 and Cu_1 each with one round light spot; anal cell with two round light spots and a basal light area (fig. 5, C). Spermathecae double, large, oval, the ducts sclerotized for a short distance (fig. 5, D).

Type Material.—Female *holotype* from La Salina, (Edo. Zulia), Venezuela, collected by Ignacio Ortiz C. in March, 1949.

Remarks.—This species is similar to *C. guyanensis* Floch and Abonnenc but differs in the wing pattern, cell R_5 having one more light spot, as well as in having a hind tibial comb with five robust bristles instead of four and a shorter labrum.

Culicoides iriartei, new species

Fig. 6

Female.—About 1.3 mm. long. Eyes narrowly separated. Labrum very short, 0.123 mm. in length, ratio of labrum to clypeus plus frons 44:70. Antenna with segments 3–9 not bead-like but of about the same size and shape thereafter an abrupt change in size and the segments longer. Palpus slightly longer than the labrum, 0.134 mm. in length, third segment much longer than the first and second, expanded with a large deep sensory pit, fourth segment wider and shorter than the fifth (fig. 6, A). Mesonotal pattern unknown. Legs brown, first and second femora with distinct distal light rings, first and second tibiae with basal ones, and third tibiae with both basal and distal ones; hind tibial comb with four robust bristles of which the first is the longest (fig. 6, B). Wing 0.98 by 0.41 mm. with abundant macrotrichia; second radial cell in a dark spot. Following the wide dark spot over the costal cell there are four light spots anterior to vein M_1, three of which are transverse and one is horizontal; the light spot adjoining the second radial cell is more or less hour-glass shaped, the one in the distal part of cell R_5 is "open" and expanded anteriorly, the horizontal one begins near the white spot over the cross-vein and reaches to the edge of the wing; vein M_2 is straddled by a dark spot which separates two broad light spots; cells M_1 and M_2 each with a distal light spot, veins Cu_1 and Cu_2 bordered with light areas and the light spot in cell Cu_1 is "open"; anal cell with two light spots of which the basal is double (fig. 6, C). Spermathecae double; large, oval, the ducts chitinized for a long distance (fig. 6, D).

Remarks.—In the pattern of the wing this species seems to be similar to *C. propinquus* Macfie from which it differs in that the light spot bordering vein M_1 originates more basally and also in the character of the light spots in cell Cu_1 and the anal cell. The species is named in honor of Dr. David R. Iriarte of Caracas, Venezuela.

Type Material.—Female *holotype* from La Salina (Edo. Zulia), Venezuela, collected by Ignacio Ortiz C. in March, 1949.

PHYSIOLOGICAL EFFECTS OF DDT ON PHORMIA LARVAE[1]

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National Institute of Arthritis and Metabolic Diseases
National Institutes of Health, Public Health Service
Federal Security Agency
Bethesda 14, Md.

INTRODUCTION

Buck and Keister (1946) reported that groups of *Sciara* larvae, after brief immersion in a kerosene solution of DDT, gained weight in distilled water faster than control larvae or larvae exposed to kerosene alone. The small size of the larvae made it impossible to separate surface contact from tracheal penetration as avenues of poisoning, or to distinguish between cutaneous penetration, drinking and other possible routes of entry of the water. We have accordingly investigated these and related questions on the much larger larvae of the blowfly, *Phormia regina* Meigen. An additional incentive was the possibility that a comparison with our physiological study of adults of the same species (Buck and Keister, 1949) might explain the common field observation that larvae are more resistant to DDT than are adults. In previous laboratory work on different developmental stages of a single species (Ludwig, 1946; Bodenstein, 1946) a pronounced difference in susceptibility was found, but it was not established whether this was due to a qualitative difference in mode of action, or merely to quantitatively different accumulation or penetration of the poison in larva and adult.

The plan of investigation was to explore four possible sites of entry or pathways by which DDT might reach responsive tissue (i.e., via skin, gut lining, tracheae or blood), and for each of these to assess four physiological responses: oxygen uptake, weight change, behavior and survival.

MATERIAL AND METHODS

Third stage larvae were collected from horse meat cultures 4 to 5 days after egg-laying (1 to 2 days before pupation at 25° C.), kept on wet filter paper for 3 to 6 hours to reduce variations in weight due to regurgitation or defecation, then stored at 6° until used (not more than 5 days). Mean live weight per larva, in 100 individuals chosen at random from 20 experiments, was 55.35 ± 0.58 mg. Initial solids averaged 30.6% in larvae dried to constant weight at 50° C.

Phormia larvae have one pair of spiracles posterolateral to the mouth and one pair dorsolateral to the anus. In certain of the weight-change experiments in which the tracheal system was to be blocked, tight

[1]Helpful suggestions of F. Babers, L. Chadwick, P. Neal, J. Pratt, A. G. Richards, K. Roeder, B. Sacktor and J. F. Yeager are acknowledged with pleasure.

ligatures of size 6–0 braided surgical silk were tied (surgeons' knot) just behind the anterior spiracles (necessarily closing the pharynx also, but not injuring the heart or ganglia) and around the posterior end of the body (with or without including the anus). In experiments in which the effects of DDT on paralyzed larvae were tested, a tight ligature was put on the fifth segment, and the anterior part containing the large ganglionic mass or "brain" was removed from control and poisoned larvae before weighing. In experiments to check the mechanical effects of ligation and the deganglionation operation, the ligature was put on segment 4, with the brain forced posterior to that point. In all ligation experiments the individual larvae were examined carefully at the beginning and end of the experiment, and any having clear liquid in any of the tracheae (blood leakage) were discarded. Where the tracheal trunks were difficult to see, for example near the anterior end where they run under the fat bodies, the tips of a slightly opened forceps were pressed against the body to displace overlying viscera.

DDT was used as dry crystals (Merck), mortar-ground aqueous suspension and paste, and in 5% solution in white, nondeodorized kerosene or in olive oil. The suspension was colored with methylene blue and the solutions with Sudan IV for locating and estimating dose.

In surface exposure tests with the kerosene solution of DDT the larvae were pinioned in filter paper girdles held in wire clamps (fig. 1), and seals of acetate cement were put over both pairs of spiracles. After hanging for 20 minutes to dry, the larvae were released, immersed in the oil for 15 minutes, blotted and unsealed. Any larvae with oil in the tracheae were discarded.

In poisoning via tracheae or blood, larvae were held in the clamp shown in fig. 2 and injected through hollow glass needles by means of an injection device (Buck, 1949). For injection into the hemocoel, chisel-pointed needles of about 50 μ bore were used, the injection being made ½ mm. lateroventral to one of the posterior spiracles. For light intratracheal injections, needles with fire-polished tips about 50 μ in diameter were used, the tip being inserted through the central one of the three slits in the left posterior spiracular plate. To reduce leakage with heavy intratracheal injections, needles large enough to occlude the whole spiracle were used (o.d. 175–200 μ). Although this necessitated breaking the spiracular plate, the operation did not have any lasting visible effect. In "probed" and "stabbed" controls an empty needle was used as a control for the mechanical effects of injection.

Although it is relatively easy to insert a needle in a larva and turn the screw of the injection syringe an amount which should correspond accurately to a known volume (Buck, Keister and Zelle, 1950), the quantity which actually stays in the larva is not infrequently reduced by leakage around the needle (which is sometimes exceedingly difficult to detect), by leakage out of the injection site after the needle is withdrawn (sometimes several minutes after), or, in intratracheal injection, by leakage through the other posterior spiracle. Furthermore, the same volume of solution may be distributed differently within the body in different instances. In intratracheal injection the oil may go into one of several different sets of tracheae, while oil injected into the posterior part of the hemocoel may either remain there or be churned

into some quite different region by the locomotory movements. We accordingly felt that it would be misleading to specify dosage quantitatively beyond the rough estimates given below, and relied rather upon microscopic examinations of the larvae about 15 minutes after injection, when conditions presumably were somewhat stabilized. We classified intratracheal doses as light, heavy, or complete, "light" indicating filling of 2 to 6 branches of the longitudinal tracheal trunks, and "heavy" indicating filling of both trunks and most of the main branches. A

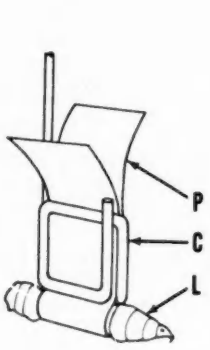

FIG. 1

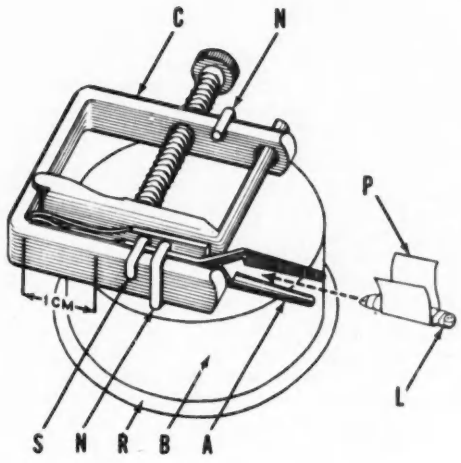

FIG. 2

FIG. 1. Clamp (C) for holding blowfly larva (L) in filter paper cummerbund (P) for sealing spiracles. Clamp made from paper clip.

FIG. 2. Adjustable press made from Hoffmann screw clamp (C) and 45 mm. artery forceps (A) for holding larva (L) in filter paper (P) for injection. Artery clamp fastened to 18 x 33 mm. cylindrical brass base (B) by finishing nails (N) driven into snug holes and bent over. Artery clamp fastened to Hoffmann clamp by horseshoe-shaped piano wire spring (S). Base made slip-proof with disk of rubber dam (R).

light dose, which is estimated to average 0.05 to 0.1 mm.^{3} per larva, killed 75–80% of the larvae in 12–48 hours. The kerosene was rapidly absorbed from the tracheae, being gone from all but an occasional fine branch at the end of 6 hours. In the course of the work it was discovered that the oil almost always filled one or more of several very long and slender tracheae which lead directly to the brain from the posterior several pairs of medial branches of the main tracheal trunks. In subsequent experiments larvae showing no oil in these tracheae were discarded.

For injecting an aqueous DDT suspension, a large needle with a slightly constricted lip was used. In loading it, 10 to 15 mm.^{3} of

suspension were taken up, and the water expelled slowly until a mass of crystals had accumulated near the needle tip. The whole mass was then expelled into the trachea by a sudden turn of the syringe screw. By this method it was possible to pack the trunk solidly with suspension, from which the water was rapidly absorbed through the tracheal wall.

In testing oral toxicity, larvae were permitted to burrow in aqueous DDT paste for several hours, or were immersed in a 5% olive oil solution of DDT for 15 minutes, then blotted. (Less viscous oils were not used because they enter the tracheae.) The dose ingested was variable, and impossible to specify quantitatively. In oil-feeding, animals were selected on the basis of attaining concentrations of colored droplets in the gut which were estimated microscopically to be of the same order of size as those which were toxic when given intratracheally or by injection into the hemocoel.

In the weight-change experiments, wet conditions were obtained by keeping larvae individually in 5 cm. petri dishes with either a 1 mm. layer of water, or wet filter paper on the bottom. In dry conditions the larvae were kept over anhydrous calcium chloride.

Oxygen uptake was measured individually at 1 and 19 mm. pH_2O ("dry" and "wet") in 15 to 19 ml. Warburg flasks by techniques previously described for adult flies (Buck and Keister, 1949). Measurements were begun after a delay of ½ to ¾ hour due to weighing, injecting, equilibration, etc., and were usually continued through the sixth hour after poisoning. The oxygen uptakes and respiratory quotients presented were calculated over at least two-hour periods of the plateaux of uptake which were reached in 3–4 hours (see figs. 3–9).

Significance of differences between mean quantities was assessed by t test, using the 2% level of significance. All experiments were run at 25° C.

RESULTS

1. *Introduction.* In view of the complexity of the findings to be presented, it is desirable at the outset to explain how the variability of the material complicated the originally straightforward plan of work. Considering the unavoidable variations in dosage, the variation between the oxygen uptakes of different individuals from the same batch of larvae was surprisingly small (see standard errors in Table I). Live weight also varied little within a given batch. Different batches, however, sometimes showed statistically significant differences in oxygen uptake even among control larvae. Presumably this was due to unrecognized differences in nutritional or developmental states, although we learned subsequently from more experienced colleagues that comparable variations are seen in larvae raised under carefully controlled conditions on synthetic media. At any rate, because of the variation it was necessary to use only batch-mates in making a given comparison. This gave the respiration experiments a particularly high coefficient of frustration because only about 100 larvae could be processed manometrically during the 5-day useful life of a given batch. This meant that only 3 or 4 classes of treatment, plus appropriate controls, could be compared simultaneously, and that duplicate control and standard poisoned groups had to be run for each batch used in a given experiment (see, for example, parts 4 and 8 of Table I).

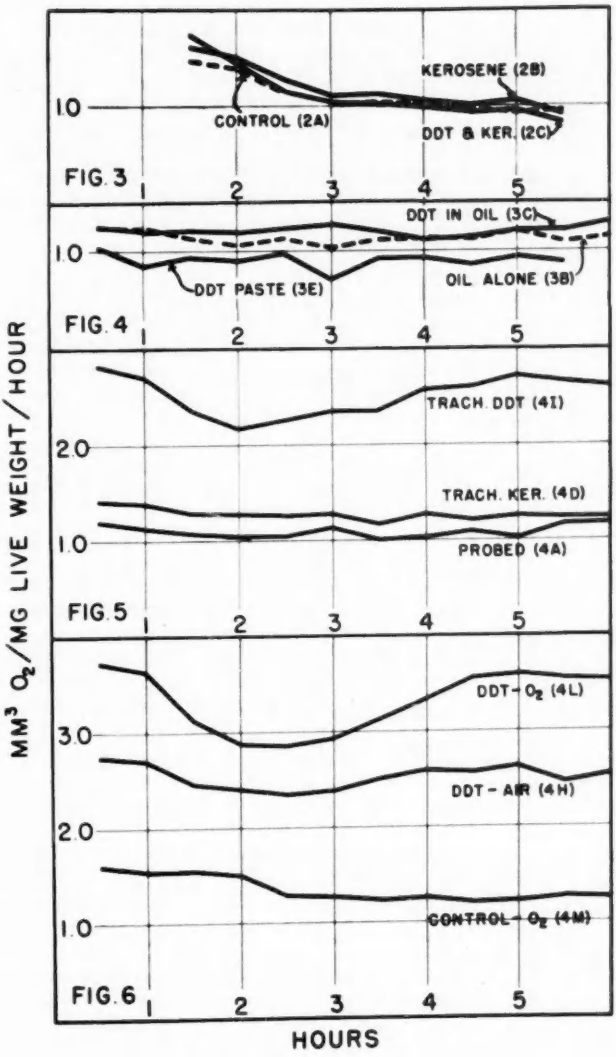

FIG. 3.[1] Oxygen uptake from air of *Phormia* larvae given contact exposure to DDT in kerosene and to kerosene alone.

FIG. 4. Oxygen uptake from air of *Phormia* larvae after ingestion of DDT.

FIG. 5. Oxygen uptake from air of *Phormia* larvae after light injections of kerosene solution of DDT into the tracheae.

FIG. 6. Oxygen uptake of *Phormia* larvae in air and oxygen after light intratracheal dose of DDT in kerosene.

[1]In this and following figures, the numbers in parentheses following the title of each curve refer to the corresponding data listed in Table I. Zero time is the time of setup in flask, and was 10–30 minutes after poisoning.

2. *Normal larvae.* Normal larvae, unless close to pupation, move almost continuously. The average oxygen uptake per larva for 76 individuals in 26 experiments was 1.05 ± 0.03 mm.^{3}/mg. initial live weight/hour, with individual uptakes ranging from 0.67 to 1.64. Comparison of air-breathing larvae with oxygen-breathing counterparts (1A vs 1B, Table I) showed that pure oxygen does not affect oxygen uptake in respiration controls. Experiments not reported in detail showed that neither probing nor stabbing with empty needles had any measurable effect on the larvae.

3. *Effects of kerosene.* Larvae given surface exposure to kerosene oil showed no lasting effect on locomotion or on oxygen consumption (2B vs 2A, Table I, and fig. 3). Kerosene administered intratracheally in light doses was similarly without significant effect on respiration in moist air (4D vs 4A, and fig. 5). In dry conditions (4E vs 4B) or in oxygen (4F vs 4G), kerosene caused a slight, but statistically significant stimulation of oxygen uptake. On the other hand, if sufficient oil entered the tracheae to cause asphyxiation (5B, 5C), oxygen uptake fell and motor activity decreased or stopped altogether. The only instance of a *pronounced* stimulatory (toxic) effect of kerosene *per se* was seen in larvae with oil injected into the hemocoel (7C vs 7A, and fig. 9).

4. *Symptoms of DDT poisoning.* The most characteristic symptoms of acute DDT poisoning are loss of ability to locomote, and increased oxygen uptake. In extremely dry conditions even normal larvae have difficulty in locomoting and may simulate to some extent the rapid, continuous, aimless telescoping movements of the body, particularly of the anterior end, which are seen in poisoned larvae. Damp filter paper was therefore used in testing all questionable cases.

5. *Effects of cutaneous exposure to DDT. Phormia* larvae withstood several days' exposure to dry DDT crystals or to a thick aqueous paste of DDT without apparent effect, pupated and emerged normally. Usually, however, the flies developed DDT poisoning soon after emergence. The significance of this fact will be discussed in the section on ingested DDT.

When put in an aqueous suspension of DDT, most of the animals became moribund overnight, whereas controls in plain water, or larvae in graphite suspension were uninjured. However, this effect was not a metabolic poisoning, but an asphyxiation caused by inability of the larvae to keep their posterior spiracles above the surface film of the water. The larvae in the suspension seemed to have fewer gas bubbles in the midgut (and hence had less buoyant posterior ends) than the controls, and it also appeared that water readily covered the posterior spiracular plates rather than being strongly repelled as in normal larvae, which suggests that DDT reduces the hydrophobic properties of the waxy coating of the spiracles.

Although initially irritated, larvae showed no lasting effect from 15 minutes' surface exposure to 5% DDT in either kerosene or olive oil, providing none got into tracheae or gut. Oxygen uptakes were almost identical with those of controls (2C vs 2A, and fig. 3).

The results indicate that DDT has no toxicity for the *Phormia* larva when applied to the external integument.

6. *Effects of ingested DDT.* Larvae which had burrowed in aqueous DDT paste were uninjured, though crystals could be demonstrated in various parts of the intestinal tract by means of the polarizing microscope. Their oxygen uptakes (3E) were apparently significantly lower, rather than higher, than those of untreated (3A) controls (fig. 4), although relatively few larvae were tested.

Practically all the larvae which had been in the paste completed development and emerged, but the newly emerged adults often developed fatal DDT poisoning. In investigating this phenomenon,

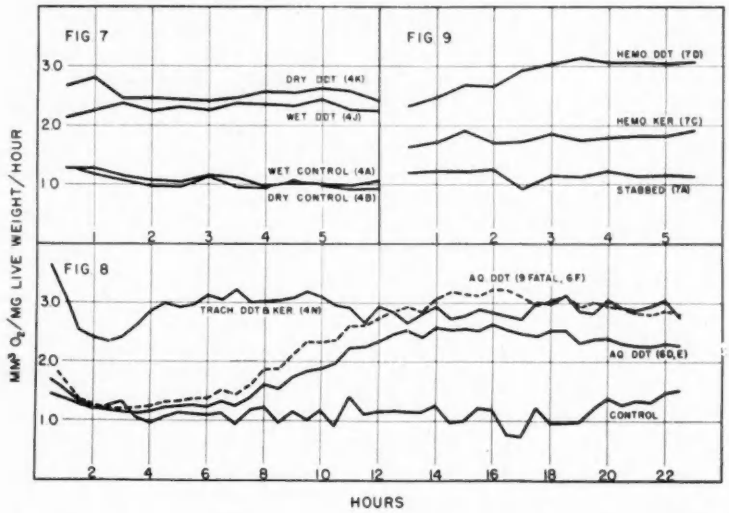

FIG. 7. Oxygen uptake from air of *Phormia* larvae in low and in high humidity after light intratracheal dose of DDT in kerosene.

FIG. 8. Oxygen uptake from O_2 over 22 hours of *Phormia* larvae with aqueous DDT suspension or DDT in kerosene injected into the tracheae. Flasks were reflushed with oxygen at 8-hour intervals. The control curve is based on only 3 animals (not listed in the Table), but the continued low level of uptake is confirmed by the water-injected controls followed from 16 to 22 hours after injection (6C).

FIG. 9. Oxygen uptake from O_2 of *Phormia* larvae after a kerosene solution of DDT has been injected into the hemocoel.

11 of 21 larvae which had burrowed overnight in aqueous DDT paste were washed thrice as larvae and thrice as pupae in large volumes of 70% ethyl alcohol, while the other 10 were allowed to pupate unwashed. Of the 8 flies in each group which emerged, 6 of the unwashed group showed clear symptoms of DDT poisoning during the first day after emergence, while all of the washed group appeared normal. It therefore appears to us more likely that the newly emerged flies were killed by DDT adhering to the puparium than by previously stored DDT liberated from the fat body as reported for *Drosophila* by Kalina (1950).

Larvae immersed in 5% DDT in olive oil often ingested droplets and occasionally showed motor hyperactivity suggesting poisoning. However, almost all of the larvae eventually pupated and emerged. Their oxygen uptakes (3C) were not significantly different from those of larvae ingesting olive oil alone (3B) or of untreated controls (3A) (fig. 4).

Assuming adequate dosage these results indicate that DDT has little toxicity by mouth in *Phormia* larvae. They also support the conclusion that DDT is not toxic to the larvae by surface contact.

7. *Effects of DDT injected intratracheally.* Larvae which had 5% DDT in kerosene injected through a spiracle into the tracheae without apparent other contact with the external body surface, or in which the solution entered the tracheae spontaneously while the larvae were submerged in it, usually were fatally poisoned, even by small amounts. Fewer than 25% pupated and of those which did form puparia some were unable to complete development and emerge. In larvae lightly poisoned with intratracheal DDT in kerosene, and respiring in *air*, plateau oxygen uptakes (4H, I, J) were more than twice those of kerosene-injected (4D) and water-injected (4C) controls (fig. 5).

In larvae poisoned by light tracheal injections of DDT in kerosene, and respiring in *oxygen*, plateau oxygen uptake was of the order of 3 times that of the controls (4L vs 4M; 8E vs 8A; 8F vs 8B) and of the kerosene-injected larvae in oxygen (4L vs 4F). Individuals had peak uptakes as high as 5.8 mm.^{3} mg./hr. The high uptake was usually maintained for at least 22 hours (fig. 8).

With heavier doses, activity and oxygen uptake were inversely proportional to dose (5D, E). The probable explanation of this effect is that with the light dose few tracheae were occluded, permitting a relatively high oxygen uptake, whereas the heavy doses seriously reduced the available respiratory surface, causing asphyxiation and preventing the increase in aerobic metabolism which otherwise presumably would have occurred.

Twenty-two larvae with heavy intratracheal injection of aqueous DDT suspension all died before eclosion. Their mean oxygen uptake in oxygen was practically unaffected during the first 6 or 7 hours after injection (6D), then rose gradually to a rate (6E) more than twice that of water-injected controls (fig. 8). Motor activity followed a parallel course, no "jitters" appearing within the first 6–8 hours. Calculated on the basis of the 9 larvae out of 22 which died without pupating (6F), the oxygen uptake approximately equalled that of kerosene-DDT poisoned larvae (4N). The delay in respiratory stimulation was not correlated with the absorption of the injected water, which was completed before uptake began to rise.

8. *Effects of DDT injected into the hemocoel.* Five per cent DDT in kerosene was usually fatal when injected through the body wall into the blood in quantities roughly estimated at ½ mm.^{3} per larva. Oxygen uptake from air (7D) averaged about 3 times that of probed controls (7A), about 2.5 times that of controls with distilled water injections (7B), and 1.7 times that of larvae given kerosene alone (7C) (fig. 9). In similar larvae respiring in oxygen (8K) rates as high as 6 mm.^{3}/mg./hr. were obtained, with a mean of 3.9 mm.^{3}. However, the larvae were from a different batch than 7D, so may not be strictly comparable.

No consistent difference in toxicity was noticed between injections consisting of a single drop and those in which the oil was distributed as a cloud of fine droplets. The toxicity of kerosene alone (7C) was much less than that of kerosene plus DDT, as indicated also by the fact that most of the larvae injected with kerosene appeared to pupate normally, and about half of these succeeded in emerging.

9. *Effects of DDT in deganglionated larvae.*

a. *Introduction.* In the experiments on deganglionated larvae (Table I, part 8), groups A, C, E, G, I and J came from one batch, B, D, F, H, K and L from a second, and groups M, N, O and P each contained equal numbers of larvae from two different batches. The results illustrate well the distressing variability discussed on page 372, and the necessity for duplicating controls and various experimental groups for each batch of larvae.

In ligated larvae the heart is presumably pinched shut posterior to its main efferent opening, hence the circulation is probably greatly impeded. However, the ligated rear ends remained responsive to touch for at least 24 hours (several days in controls), during which period their hearts were either beating or could be induced to beat by mechanical stimulation. Control larvae ligated behind the brain became motionless. Their posterior portions showed a significantly lower rate of oxygen uptake from oxygen than did untreated controls in one batch (8C vs 8A) but not in the other (8D vs 8B).

b. *Effects of deganglionation after poisoning.* In larvae ligated behind the brain 4 hours *after* being poisoned *intratracheally* with DDT in kerosene, the posterior segments became practically or entirely motionless after the ligature was applied, whereas the anterior ends, before they were cut off, continued to show the contractions typical of poisoning. As in ligated controls, however, the posterior portions still showed a slow, localized contraction of body wall muscles in response to, and proportional to, direct mechanical stimulation. The oxygen uptake of the posterior portions of intratracheally-prepoisoned larvae was the same (8G vs 8A) or slightly higher (8H vs 8B) than that of normal controls, and markedly above that of ligated controls (8G vs 8C; 8H vs 8D), but was very much lower than that of unligated poisoned larvae at the 4-hour mark (8G vs 8E; 8H vs 8F). It was also much lower than that of tracheally poisoned larvae ligated in front of the brain (8G vs 8I), showing that the depression of oxygen uptake in deganglionated poisoned larvae was not due to the inactivation of the anterior spiracles.

Larvae ligated 4 hours after injection of DDT-kerosene *into the hemocoel* continued to show uncoordinated contractions and writhings of the posterior segments, and had oxygen uptakes significantly higher than both controls and intratracheally poisoned-ligated larvae (8L vs 8H).

c. *Effects of deganglionation before poisoning.* In larvae deganglionated immediately *before* being injected *intratracheally* with DDT in kerosene, no visible symptoms of poisoning developed, although oxygen consumption was apparently slightly higher than that of ligated controls (8J vs 8C). Larvae ligated before injection of DDT *into the hemocoel* showed a similar lack of visible symptoms of poisoning,

and consumed oxygen at a rate significantly lower than that of controls (8O vs 8M), and not significantly higher than that of animals injected with kerosene alone (8O vs 8N).

10. *Effect of humidity on course of DDT poisoning.* There was no statistically significant difference between the oxygen uptakes of wet and dry controls (4A vs 4B) or between wet and dry poisoned larvae (4J vs 4K) (see fig. 7). This contrasts with the inhibition of uptake by low humidity seen in adult flies (Buck and Keister, 1949).

11. *Effect of DDT on respiratory quotient.* The respiratory quotients of larvae respiring in moist air, calculated from the plateau gas exchange in flasks with and without absorption of CO_2, were 0.74 in controls and kerosene-injected larvae, and 0.84 in larvae given a light tracheal injection of DDT in kerosene. No account was taken of possible CO_2 retention in the larva.

12. *Weight changes in larvae.* Experiments on some 650 individuals showed that (1) intratracheally-poisoned larvae, 6 hours after poisoning, had lost significantly more weight (18%) in dry conditions than either control (5%) or kerosene-injected larvae (5.5%), and (2) intratracheally-poisoned larvae gained weight (5.9%) in wet conditions, while controls and kerosene-treated larvae lost (6.5 and 2.1%, respectively). Analogous but less pronounced changes were obtained in larvae given DDT in kerosene by injection into the hemolymph and DDT in olive oil by mouth, but not with DDT solutions applied to the skin alone. Ligation experiments indicated that a statistically significant, though not large, amount of weight was lost by regurgitation. Paths of weight change will be considered below.

DISCUSSION

a. *Sites of penetration of DDT.* The fact that *Phormia* larvae were unaffected by surface contact with DDT as dry crystals, paste, or in kerosene or olive oil solution, but were highly susceptible to DDT introduced into the tracheae or blood, indicates that the external body integument is essentially impervious to DDT. This is in striking contrast to the high contact toxicity of DDT to the adults of many insects, including *Phormia*, and the results with DDT solution are particularly noteworthy because kerosene in itself is ordinarily thought to have considerable contact toxicity. It could perhaps be objected that the 15 minutes in the solution was an inadequate exposure in comparison with the continuing contact in intratracheal poisoning (though 0.1 $mm.^3$ applied to the dorsum of the thorax of the adult fly is rapidly toxic). However, this objection will not apply to the tests with crystalline DDT. From our findings it seems possible that an impervious skin might explain the reported low toxicity of DDT in one form or another to the larvae of *Musca* (Olson and Dahms, 1945), *Lucilia cuprina* (Waterhouse, 1947) and other species.

The experiments on oral uptake of DDT did not give any evidence that DDT can act as a stomach poison in *Phormia* larvae, but the results are not rigorously conclusive because we have no quantitative evidence that the amounts ingested were equal to or greater than those which would have been toxic by injection. Similarly, the fact that the death of newly-emerged flies derived from larvae given DDT orally can be

ascribed to secondary contact with DDT on the surface of the puparia does not prove that DDT cannot poison via the gut.

The immediate toxicity of DDT oil solution, when introduced into the tracheae, is presumed to be due to rapid passage of the vehicle through the tracheal intima (in contrast to its non-penetration of the external integument) and to the fact that the tracheae offer a direct path to the nerve centers. The delayed but high toxicity of dry DDT crystals in the tracheae is attributed to a direct effect on the neuromuscular system by DDT which gradually passes through the tracheal lining into the blood. This interpretation is supported by the fact that DDT solution introduced directly into the hemocoel shows a rapid and high toxicity (fig. 9), even allowing for the considerable stimulation due to the kerosene itself (7C).

The results of our study suggest that under ordinary field conditions in which a solution of DDT in a low-viscosity oil is used to control blowfly (or at least *Phormia*) maggots, the major factor in the effectiveness of the treatment would probably be a direct asphyxiation by oil blockage of the tracheae. DDT would not be effective as a contact insecticide; would be of dubious value as a stomach poison; and would only rarely be able to act as a primarily neurotoxic agent.

b. *Effect of DDT on respiration.* The marked increase in oxygen uptake seen in poisoned larvae is qualitatively similar to that in adult flies (Buck and Keister, 1949). The fact that the mean increase is somewhat smaller than in poisoned adults is probably due, first, to the larval control uptake not being a true resting uptake (the larvae moving about a good deal, whereas the adults often remain motionless for long periods) and, second, to the comparatively limited potentialities of the (wingless) larvae for increasing their muscular activity.

In another investigation (Buck and Keister, 1950, and in preparation) we give evidence that the lower oxygen uptake of poisoned larvae in air as compared with those in oxygen (4H vs 4L) may be due to limitation of gas intake by the spiracular aperture. This is significant in the present work only in indicating the desirability of using oxygen atmospheres when comparing uptakes of acutely poisoned larvae.

The shift in respiratory quotient from 0.74 to 0.84 can be interpreted, as in the adult, to indicate increased utilization of carbohydrate in connection with the increased muscular work. Assuming that all the oxygen taken up is involved in oxidation of carbohydrate and fat, and that there is an over-all tripling of uptake with poisoning, the observed shift would correspond to an increase in fat oxidation of something less than twice, while carbohydrate oxidation increased nearly 11 times.[2]

The finding that oxygen uptake in intratracheally-poisoned larvae is initially high, then drops markedly, then rises again after 2 or 3 hours, whereas uptake rises steadily after poisoning via the hemocoel (figs. 5, 9), is unexplained. In view of the variability between different batches of larvae and the uncertainties of dosage it seems likewise premature to speculate about the apparently greater respiratory stimulation caused by intratracheal DDT solution as compared with that injected into the hemocoel (8F vs 8K) and the relative toxicity of

[2]Calculation suggested by Dr. L. Chadwick.

crystalline and dissolved DDT given intratracheally. On the basis of the estimated intratracheal dose for solution (p. 371), which corresponds to 60 mg kg for LD_{80}, the toxicity is of the same order as for certain adult insects (Metcalf, 1948).

c. *Site of action of DDT.* The effect of DDT on *Phormia* larvae, like that on adult insects and on most other larvae,[3] suggests neuromuscular excitation. However, our observations do not lead to a simple picture of the pathway of poisoning. Thus larvae ligated behind the brain *after* poisoning had oxygen uptakes much lower than unligated larvae (8H vs 8F; 8G vs 8E; 8L vs 8K) or larvae ligated *in front of* the brain (8J vs 8I). This shows that a very significant proportion of the motor stimulation involved central activity. However, deganglionation interrupts afferent as well as efferent pathways, so that our findings do not distinguish between reflex central activity, such as that induced in afferent fibers in adult *Periplaneta* by low concentrations of DDT (Roeder and Weiant, 1946; Tobias and Kollros, 1946), and possible central activity caused by direct action of DDT on the ganglionic mass. In this connection, Yeager and Munson (1945 and personal communication) and Tobias and Kollros found no evidence that the brain could be stimulated directly in the roach, whereas Dresden (1948) reported that DDT affects synaptic transmission. If the distribution of Sudan IV is any indication of the distribution of the DDT solution in our experiments, the pink color acquired by the brain, particularly after intratracheal injections, might indicate that DDT at least penetrated the central nervous system.

In the preceding paragraph it was shown that the depression of oxygen uptake caused by deganglionation in poisoned larvae argued for an effect of DDT on or through the central nervous system. However, these same larvae (ligated *after* poisoning) had uptakes significantly higher than the ligated controls (8G vs 8C; 8H vs 8D; 8L vs 8D). This shows either that some peripheral nervous activity persisted after the central nervous system had been eliminated, or that muscle was stimulated directly by the DDT. The fact that larvae ligated *before* poisoning showed no visible muscular activity and had uptakes of the same order as those of the controls (8J vs 8C; 8O vs 8M) suggests that little direct stimulation of either muscle or motor nerve occurred (see below, however). Persistence in motor nerve of excitation initiated elsewhere was also seen in *Periplaneta* legs by Yeager and Munson, but in addition they found strong evidence of excitation in motor nerve initiated by direct action of concentrated DDT. The same conclusion was reached by Bodenstein from his success in inducing "jitters" in *Drosophila* larvae deganglionated *before* the injection of DDT into the hemocoel. Assuming that the mechanism of poisoning is actually the same in *Phormia* larvae, *Drosphila* larvae and adult *Periplaneta*, our evidence against direct stimulation of motor nerve by DDT may be reconcilable with the contrary evidence of Yeager and Munson, and with the fact that there *is* residual efferent activity in *Phormia* larvae ligated *after* poisoning, by postulating differences in effective contact with the poison. Thus in the roach, where DDT was applied directly to

[3]Except *Lucilia cuprina*, according to Waterhouse.

the leg nerves, and in the prepoisoned *Phormia* larvae, which moved actively and with unimpeded circulation for four hours before being ligated, the exposure to DDT was undoubtedly much more thorough than in the larvae ligated before poisoning, which were paralysed from the start. This suggestion, however, would not explain the discrepancy between our finding and that of Bodenstein, unless the difference is connected with the smaller size of the *Drosophila* larva or with a possible increase in the effectivenesss of the DDT solution caused by the emulsification procedure of Bodenstein.

It is perhaps noteworthy that ligation seems to reduce muscular activity and oxygen uptake in intratracheally-poisoned larvae more markedly than in larvae poisoned via the hemolymph, though the poisoning in unligated larvae is, if anything, more severe after the former than after the latter method of administration. This result could indicate that in intratracheal injection the poisoning is initiated in the ganglion and that little or no DDT reaches peripheral motor nerve either directly through tracheae, through the blood, or by diffusion through nervous tissue from the ganglia, whereas in hemocoel injections some direct motor nerve stimulation occurs in addition to that involving the ganglia.

In summary, assuming that the increased oxygen uptake in poisoned *Phormia* larvae is due to increased muscular activity, and that the ligation and removal of the first four body segments effects a complete deganglionation, our results indicate that DDT, in the concentration we used, induces muscular hyperactivity mainly by way of central excitation (reflex or direct), but partly also via direct action on the motor nerves.

d. *Weight changes in larvae exposed to DDT.* The negligible dry weight changes within the experimental periods, the lack of evidence of any but minor changes via mouth or anus, and the fact that there was no difference in oxygen uptake in wet and dry conditions, indicate that the changes in live weight observed can be ascribed mainly to water. The enhanced live weight loss of poisoned larvae in dry conditions seems interpretable on the assumption that DDT causes the spiracles to remain open, as it does in fireflies (Buck, 1948). Because of the small size of the spiracles this assumption could not be tested observationally. The enhanced weight gain of poisoned larvae in wet conditions is much more difficult to explain. It cannot be ascribed to drinking because poisoned larvae with mouth (alone) ligated also gained weight. Similarly, increased permeability of the skin cannot account for the increase, since larvae thoroughly exposed to DDT in oil, but not showing respiratory or motor symptoms of poisoning, gained only a trifling amount, and in dry air showed no indication of an increased permeability to outgoing water. The possible gain in weight due to metabolic water formed in excess of substrate respired was calculated to be negligible even if evaporation from the body was entirely prevented by the high humidity. Most of the results are qualitatively consistent with the hypothesis that the weight gain was due mainly to water leaking in through the posterior spiracles after DDT (and kerosene to a smaller extent) had decreased their hydrophobic properties. However, it was not possible to test the hypothesis by ligating the spiracles, as this made the larvae anoxic and modified the manifestations of poisoning.

TABLE I

OXYGEN UPTAKE OF *Phormia* LARVAE

(Larvae at 19 mm. H_2O vapor pressure unless labeled "dry" and in air unless labeled "O_2." Tracheal doses "light" (see text) unless otherwise specified.)

Ref. No.	Treatment	No. larvae	Mean plateau O_2 uptake mm.^{3}/mg. live wt./hr.
	Effect of Oxygen controls		
1A	Controls	27	1 15 ± 0 03
B	Controls (O_2)	23	1 15 ± 0 05
	Cutaneous contact		
2A	Clamped controls	8	1 02 ± 0 05
B	Kerosene	15	1 08 ± 0 04
C	DDT in kerosene	14	0 99 ± 0 06
	Ingestion		
3A	Untreated controls	7	1 13 ± 0 02
B	Olive oil alone	16	1 12 ± 0 04
C	Olive oil + DDT	15	1 22 ± 0 07
E	DDT paste	10	0 89 ± 0 05
	Tracheal injections (small needle)		
4A	Probed controls	11	1 07 ± 0 03
B	Probed controls, "dry" (cf. 4A)	15	0 99 ± 0 02
C	Distilled water	16	1 18 ± 0 04
D	Kerosene	18	1 23 ± 0 05
E	Kerosene, "dry"	14	1 22 ± 0 04
F	Kerosene (O_2)	41	1 32 ± 0 04
G	Controls for 4F (O_2)	40	1 07 ± 0 04
H	DDT in kerosene (cf. 4L)	20	2 55 ± 0 08
I	DDT in kerosene (cf. 4D)	26	2 52 ± 0 14
J	DDT in kerosene (cf. 4K)	13	2 32 ± 0 10
K	DDT in kerosene, "dry," (cf. 4J)	12	2 51 ± 0 14
L	DDT in kerosene (O_2) (cf. 4H)	18	3 45 ± 0 06
M	Controls for 4L (O_2)	10	1 24 ± 0 05
N	DDT in kerosene (O_2) (cf. 6E) 16 to 19 hr. after inj	12	2 94 ± 0 13
	Tracheal injections (large needle)		
5A	Probed controls	33	1 03 ± 0 03
B	Kerosene, heavy dose	7	0 73 ± 0 03
C	Kerosene, complete	7	0 36 ± 0 03
D	DDT in kerosene, heavy dose	6	1 03 ± 0 03
E	DDT in kerosene, complete	7	0 30 ± 0 01
	Aqueous injections into tracheae		
6A	Untreated controls	13	1 15 ± 0 11
B	Dist. H_2O injected immed. before exper.	30	1 12 ± 0 03
C	Dist. H_2O injected 16 hr. before exper.	23	1 18 ± 0 05
D	Aq. DDT injected; mean from 3½–6 hr. (O_2)	22	1 20 ± 0 05
E	Aq. DDT injected (cf. 4N); mean from 16–19 hr. (O_2)	22	2 48 ± 0 17
F	Fatally poisoned larvae from 6E (O_2)	9	3 08 ± 0 12
	Injections into hemocoel		
7A	Stabbed controls	9	1 13 ± 0 06
B	Dist. H_2O injected	10	1 23 ± 0 03
C	Kerosene injected	10	1 81 ± 0 18
D	DDT in kerosene	14	3 04 ± 0 26

TABLE I—(Continued)

Ref. No.	Treatment	No. larvae	Mean plateau O_2 uptake mm.^{3}/mg. live wt./hr.
	Ligation experiments (all in O_2)		
8A	Untreated controls (cf. 8C, E. G. I. J)	17	1.30 ± 0.04
B	Untreated controls (cf. 8D, F, H, K. L)	16	1.31 ± 0.05
C	Ligated controls (cf. 8G)	12	0.89 ± 0.03
D	Ligated controls (cf. 8H)	16	1.22 ± 0.02
E	Unligated; tracheally poisoned (cf. 8G)	16	3.17 ± 0.11
F	Unligated; tracheally poisoned (cf. 8H)	19	4.84 ± 0.11
G	Ligated behind brain after tracheal poisoning (cf. 8A, C, E)	16	1.32 ± 0.06
H	Ligated behind brain after tracheal poisoning (cf. 8B, D, F)	19	1.50 ± 0.04
I	Ligated ant. to brain after tracheal poisoning (cf. 8J)	16	3.08 ± 0.07
J	Ligated behind brain before tracheal poisoning (cf. 8I)	21	1.06 ± 0.04
K	Unligated; hemolymph-poisoned (cf. 8L)	19	3.92 ± 0.25
L	Ligated behind brain after hemolymph-poisoning (cf. 8K)	16	1.84 ± 0.11
M	Untreated controls (cf. 8N, O. P)	24	1.06 ± 0.05
N	Ligated behind brain before kerosene in hemolymph	23	0.85 ± 0.03
O	Ligated behind brain before hemolymph-poisoning	30	0.91 ± 0.06
P	Unligated; hemolymph-poisoned (cf. 8O)	24	1.68 ± 0.14

SUMMARY

1. DDT is toxic to *Phormia* larvae in doses of the same order as those toxic to adult insects, when introduced as an oil solution into the blood or tracheal system. It is also toxic, after considerable delay, if introduced intratracheally in aqueous suspension. It has little, if any, toxicity when ingested as crystals or in olive oil solution.

2. The larval skin of *Phormia* is impervious to DDT, either alone or in solution.

3. In larvae showing symptoms of poisoning, DDT enhances oxygen uptake, water loss under dry conditions, and water gain under wet conditions.

4. Oxygen uptake in dry conditions is not significantly different from that in wet conditions in either control or poisoned larvae.

5. There are some indications that DDT reduces the hydrophobic properties of the posterior spiracles.

6. DDT has no apparent effect on cutaneous permeability to water.

7. The respiratory quotient rises from 0.74 to 0.84 in DDT poisoning.

8. Oxygen uptake of poisoned larvae is markedly decreased by ligating behind the brain, indicating that the high uptake characteristic of DDT poisoning is due to neuromuscular activity. Some direct stimulation of peripheral nerves may be involved in addition to that mediated by the central nervous system.

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ON INDIAN INSECT TYPES, III. THE SKELETO-MUSCULAR MECHANISM OF *STENOBRACON DEESAE* CAMERON (BRACONIDAE, HYMENOPTERA)—AN ECTOPARASITE OF SUGARCANE AND JUAR BORERS OF INDIA. PART I. HEAD AND THORAX. by S. Mashhood Alam, Aligarh Muslim University Publications (Zoological Series), April, 1951. Pp. 74, 119 figs. on IX plates, frontispiece. Price Rs 5/8.

The first two studies in this proposed series of seven, "On Indian Insect Types," describe the buffalo-louse, *Haematopinus tuberculatus* Brown, (Anoplura) and the sugarcane leaf hopper, *Pyrilla perpusilla* Walk., (Homoptera), previously noticed in Annals 43: 74, 1950, and 44: 293, 1951. The present article is restricted to the structural aspects of the exoskeleton and the muscles of the head and thorax, with comments on their functional interrelations. The author has followed the plan of the works of Snodgrass and Duncan, and has made frequent critical comparisons with the interpretations of these investigators, particularly with reference to the honey bee and the vespine wasps. The descriptions are detailed, clearly and logically presented with adequate primary and secondary topical divisions, richly illustrated with fully lettered line drawings and full references in the text to the illustrations and bibliography. One wishes that some of the drawings were larger to carry better the wealth of lettering provided. Doctor Alam has obviously devoted much painstaking effort to effect this careful and important study. A companion article on the structure of the abdomen and the internal anatomy of this useful braconid is promised.—W. V. Balduf.

A REVIEW OF THE NEARCTIC STRATIOMYINI

(Diptera, Stratiomyidae)

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James (1936) proposed a classification of the Nearctic Stratiomyinae, based particularly on antennal structure and wing venation. Although the key presented in that work requires some modification, and some details, involving particularly generic reassignment of some species referred to *Odontomyia*, need to be reconsidered, subsequent experience with Nearctic as well as exotic forms seems to indicate that the classification in basically sound. The greatest gaps in our understanding of these generic complexes are, perhaps, the lack of fossil evidence and the fragmentary knowledge of immature stages.

The above mentioned classification does not differentiate the Stratiomyinae into tribes, but does lay the foundation for such a differentiation. The tribe Cyphomyiini was subsequently erected by James (1940) for *Cyphomyia*, *Dicyphoma*, and two Neotropical genera, and, later, the tribe Myxosargini (James, 1942) for *Myxosargus*, *Nothomyia*, and related genera. These two groups, which include but a relatively small element of the Nearctic fauna, leave the important *Eulalia-Stratiomys* complex. This was treated monographically, as *Odontomyia* and *Stratiomyia*, by Johnson (1895). Later, James (1936a) monographed *Eulalia* (as *Odontomyia*), in a sense more restricted than that of Johnson, though broader than that of the present paper.

The present classification proposes, in addition to the Cyphomyiini and the Myxosargini, two other tribes: the Eulaliini, which, so far as the Nearctic forms are concerned, is equivalent to *Odontomyia* as used by James (1936a); and the Stratiomyini, which will include, so far as the Nearctic forms are concerned, three genera: *Stratiomys*, *Hoplitimyia*, and *Labostigmina*. The limits of these genera are precisely as set down by James (1936).

Of the four tribes the Cyphomyiini seem to be the most primitive, as indicated by the ten-segmented, relatively unmodified antenna, the relatively complete wing venation, the robust, usually non-patterned body, and perhaps, the predominantly tropical habitat. The Mysosargini, though showing some quite primitive characters, have progressed a long way in certain directions (*cf.* James, 1950, pp. 251–2) with tendencies to converge toward the Sarginae, whereas the Stratio-

[1]Maurice T. James has prepared the part of this paper which deals with general features of classification and has assisted George C. Steyskal very materially in the preparation of the part dealing with the classification of the genus *Stratiomys*, the only part to which the latter author has contributed.

myini and Eulaliini have progressed in a quite different direction, the Stratiomyini being the more primitive of the two. The Adoxomyiinae (Clitellariinae of authors) separate close to the stem of the Stratiomyinae, and it is somewhat doubtful whether the two subfamilies should be maintained as distinct.

The separation of the Myxosargini and Cyphomyiini from each other and from the *Eulalia-Stratiomys* complex is quite discrete and easy to indicate; but the separation of the Eulaliini and the Stratiomyini from each other is not so clear. These are, however, two quite distinct groups and experience can clarify in one's mind the tribal concept; yet, except for the differentiation or lack of differentiation of the antennal style, the tribes can best be defined by tendencies rather than by definite, invariable characters. Unfortunately, Nature does not always erect discrete categories and stamp them with clear tags. In attempting to read her record, one must look at the totality of characters, rather than the "key" ones. Classifications based upon such a foundation may be more difficult to define, but they are more nearly natural.

KEY TO THE TRIBES AND GENERA OF NEARCTIC STRATIOMYINAE

1. Antenna ten-segmented, the flagellum consequently composed of eight segments with at most the last one forming a style; venation strong, with three median branches and with crossveins r-m and m-cu both present and strong; abdomen broad, occasionally bicolored but without distinct patterns; face never protruding before plane of antennal insertion ..... **CYPHOMYIINI**
   - Tenth antennal segment forming a style; scutellar spines small, preapical, their tips barely reaching apex of scutellum ..... **Dicyphoma**
   - Tenth antennal segment not style-like; scutellar spines strong, approximated, apical ..... **Cyphomyia**

   Antenna eight-segmented, the flagellum consequently reduced to six segments, of which the terminal two or three may be modified into a style or an arista 2
2. Second anal vein slightly though distinctly sinuate; antenna with the last two or three segments forming a distinct, relatively long style or arista; face often strongly produced downward; abdomen slender, in Nearctic forms never patterned ..... **MYXOSARGINI**
   - Antenna with a style; face produced angularly downward ..... **Myxosargus**
   - Antenna with an arista; face not produced downward ..... **Nothomyia**

   Second anal vein not at all sinuate; face sometimes tuberculate or produced forward, but never downward; abdomen short and broad, normally patterned, black and yellow or black and green, though sometimes one or the other of these colors may so strongly predominate as to eliminate the pattern 3
3. Last two antennal segments modified into a distinct, though usually short and often blunt style; venation somewhat reduced, with either r-m missing or M_1 and or M_3 reduced to a stump or a weak fold (except *Anoplodonta*, v.i.); ratio of first to second antennal segment not more than 1.5:1 ..... **EULALIINI**
   - Crossvein r-m and veins M_1 and M_3 present and distinct; scutellum without a trace of spines ..... **Anoplodonta**
   - Crossvein r-m present or absent; if present, vein M_3 wanting or greatly reduced and vein M_1 also often more or less reduced; scutellum with distinct, though sometimes small, spines.
     - Crossvein r-m absent, veins M_1 and M_3 present; face either receding or tuberculate below base of antennae, wholly green or yellow between antennae and oral margin, except in *H. trivittatus*, which has a pair of small black spots ..... **Hedriodiscus**
     - Crossvein r-m present, vein M_3 wanting or greatly reduced, vein M_1 also often more or less reduced; face often with extensive black areas or wholly black ..... **Eulalia**

Antenna without a style; venation not reduced, except that in *Labostigmina* r-m may be missing or rarely (*L. defecta*) M_3 reduced to a spur and fold; scutellum spined, though in some cases (some *Labostigmina*) the spines may be very weak and sometimes practically absent; ratio of first to second antennal segment at least 1.25:1, usually 2:1 or greater..... **STRATIOMYINI**

Face receding; scutellar spines strong, located on the outer corners and outside the median third; ratio of first to second antennal segment from 2.5:1 to 5:1..... **Stratiomys**

Face produced or tuberculate; if tuberculate, the tubercle involving the antennal insertion.

Flagellum flattened; head wider than thorax; eyes angular in profile; ratio of first to second antennal segment 4:1 to 5:1; scutellar spines strong..... **Hoplitimyia**

Flagellum cylindrical or almost so; head no wider than thorax; eyes rounded in profile; ratio of first to second antennal segment 1.25:1 to 2.5:1; scutellar spines weak or evanescent..**Labostigmina**

Tribus **Stratiomyini** James, nova

Genus **Stratiomys** Geoffroy

1762, Hist. Abregée Ins. 2: 476; *Stratiomyia* Loew, 1865, Berliner Entom. Zeits. 9: 130 (Centuria VI, 4; *idem*, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 227; *idem*, Aldrich, 1905, Smithsonian Misc. Coll. 46: 182 (catalogue); *Stratiomys* Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 199; *idem*, James, 1936, Jour. Kansas Entom. Soc. 9:36. Type, *Musca chameleon* L.

Examination of types by one of us (James) has resulted in several changes of names and some synonymy, all of which is noted below. The genus is a difficult one with many of the specific distinctions made perforce on characters of color. The male terminalia are small and simple; in several species examined, no distinctions were discernible.

KEY TO THE NEARCTIC SPECIES OF *STRATIOMYS*

1. Antenna short, the first segment normally not more than three times as long as the second, the flagellum at least two times as long as the first segment; abdomen flattened, the venter either entirely yellow or with black basal bands or spots; Western species (*laticeps* group)..... 2

   Antenna longer, the first segment normally four or more times as long as the second, the flagellum less than two times as long as the first segment; venter partly or wholly black..... 4

2. Abdominal sternites each with a black basal band; male with eyes usually distinctly hairy; both sexes with femora, except extreme apices, black, only in rare cases brown, but still darker than the tibiae..... **laticeps**

   Abdominal sternites wholly pale or with narrow basal spots or bands; eyes in both sexes bare; female with femora yellow, at least at base..... 3

3. Pleura wholly black; venter sometimes marked with black, usually wholly yellow or nearly so; female with femora usually in part black, male with femora black except apical fourth or more..... **currani**

   Pleura with conspicuous areas of yellow or brown ground color; venter yellow; femora of female entirely yellow, of male yellow, but often with a preapical black or blackish annulus..... **bruneri**

4. Fourth abdominal tergite with an oblique black mark interrupting lateral yellow spots on each side; eyes hairy in both sexes..... **maculosa**

   Fourth abdominal tergite not so colored; eyes bare, except in male of *S. badia*..... 5

5. Posterior orbit broader below than above and broadly yellow at least in its lower part; in the female yellow throughout or at most black in its upper fourth, bare except for short, inconspicuous hairs, and broad throughout, its minimum breadth at least equal to length of second antennal segment; in the male distinctly broadened in the lower part;

facial orbits broadly yellow (except in some high altitude males of *S. barbata*); sternites with posterior yellow portion approximately equally developed on all segments, or at most only slightly more so on the anterior segments (*S. chameleon*, typical group) 6

Posterior orbit not much broader in lower part, narrow throughout in the male, relatively so in the female, its minimum breadth usually distinctly less than length of second antennal segment; yellow color of posterior orbit usually narrow or lacking; if posterior orbit is relatively wide or somewhat broadened and yellow on lower half or more, it is clothed in part with conspicuous tomentum and the posterior yellow portion of the sternites is definitely more strongly developed on the anterior than on the posterior segments; eyes bare in both sexes 10

6. Head as wide as thorax; eyes of female separated at antennae by at least 0.53 of the total head width; posterior pale margin of fourth tergite continuous and distinctly produced forward medianly; pale mark of fifth tergite a practically parallel-sided median longitudinal bar; femora usually brown basally; ventral segments usually at least half black, rarely mostly pale, the black portion practically parallel across segments; face largely pale with median black stripe; eyes of male hairy. (Transcontinental in the North) ..... **badia**

Head distinctly narrower than thorax; eyes of female rarely separated at antennae by as much as 0.5 of the total head width; posterior pale margin of fourth tergite, if continuous, not conspicuously produced forward medianly; eyes bare in both sexes 7

7. Each sternite usually at least half black, the black portion forming a parallel-sided anterior transverse band; posterior pale portion of fourth tergite usually interrupted medianly; pale marking of fifth tergite consisting of a median triangle which is widest posteriorly; femora, except knees, black; face of male usually largely black, usually with black pile. (Western; eastward to Colorado and Manitoba, but probably farther in the North) ..... **barbata**

Sternites usually predominantly yellow, each with a black anterior transverse band which is broadest in the middle; posterior pale portion of fourth tergite continuous, or, if interrupted, usually with a pale median triangle in the intervening space and always with mesonotal pile predominantly pale; pale marking of fifth tergite either a parallel-sided median longitudinal bar, sometimes somewhat expanded at each end, or a pentagon which is widest anteriorly; face largely pale 8

8. Posterior margin of fourth tergite with transverse lateral markings and usually isolated median triangle, pale; front of female (fig. 18) black except for three rounded pale spots, one anterior to median ocellus and one on each side of the ocellar triangle, which form a conspicuous triad when viewed from above; posterior orbit of female wider at minimum than length of second antennal segment; femora of female largely black, of male black on apical half, more extensively so ventrally; fifth tergite with a broad but parallel-sided median longitudinal bar. (Northeastern) ..... **lativentris**

Posterior pale margin of fourth tergite continuous, rarely narrowly interrupted, but when so without an isolated median triangle; front of female pale on anterior half, except sometimes adjacent to each eye; male with femora, except knees, nearly wholly black 9

9. Fifth tergite with at least a small yellow lateral mark on each anterior corner and with a median parallel-sided bar which is sometimes expanded at each end, its anterior end sometimes fused with the lateral spots; oral margin of female at least in part, usually largely, yellowish; femora of female yellowish, sometimes piceous subapically; posterior orbit of female about as wide at its minimum as length of second antennal segment. (Chiefly northeastern) ..... **obesa**

Fifth tergite black at sides but with a conspicuous median pentagonal marking which is usually distinctly broader anteriorly; oral margin black; femora, except knees, black, rarely largely yellowish in female. (Western) ..... **melastoma**

10. Second and third ventrites largely or wholly pale and contrasting with the ventrites posterior to them, which are almost wholly black; second ventrite nearly always wholly pale; third ventrite at darkest (fig. 16) with continuous anterior margin, widest medianly, and posterior corners filled in with black so that the entire posterior margin is black; abdomen strongly convex, usually as high as the thorax when viewed laterally; second and third tergites each with broad lateral spots which form a continuous margin, that of the third tergite often smaller, but never deeply incised; fourth tergite never with a median apical triangle nor with lateral inward extensions of the yellow color apically; head, thorax, and legs with abundant, long, pale pile, that of metapleura pale; third and fourth tergites of male with long, erect, black pile, fifth tergite with recumbent yellow pile; venter with coarse, long, yellowish hair; scutellum largely black, only spines and a small area between them yellow 11

Third ventrite wholly black or with a considerable amount of pale color, if with much pale color, that color at lateral and posterior margins, the black color concentrated anteriorly and medianly; fourth and fifth ventrites either wholly black or distinctly bicolored; species differing also in one or more of the other characters 12

11. Base of hind femur black, or at most a little piceous; third ventrite usually wholly pale (fig. 13), except sometimes a small anteromedian spot or a narrow anterior margin of black; profile of lower head (figs. 1–3, 7–8) characteristic; length 9.8–13 mm. (Widespread) ..... **discalis**

Base of hind femur pale, yellowish or brownish; third ventrite typically with a black triangle in each posterior corner, but the black may be more extensive as described above (couplet 10, and figs. 14–16); profile of lower head (figs. 4–6, 9–10) characteristic; length 12.2–14.2 mm. (Widespread) ..... **adelpha**

12. Predominantly black species, the abdominal tergites wholly black except occasionally traces of yellow markings on the median line of the fifth segment, and laterally or at the anterior corners of the second segment, the ventrites also black except for narrow posterior margins which are only rarely extended; metapleural pile largely black; mesonotum with thick gray or yellow pile. (Southern and Western) 13

Abdominal tergites with conspicuous markings on at least the second segment, if without, ventrites with considerable yellow laterally; metapleural pile pale or dark 14

13. Hair of abdomen, including that of venter, largely black; legs black, except base of tibiae and tarsi; pile of mesonotum gray. (Western) ..... **nevadae**

Hair of abdomen short and sparse, but whitish; tibiae largely yellow, tarsi wholly so; base of femora brown; pile of mesonotum yellow. (Mississippi) ..... **hulli**

14. Second, third, and fourth tergites with continuous yellow posterior margin, the yellow extensive and forming an entire lateral margin as well; venter also with extensive yellow color laterally and posteriorly on each segment, the posterior margin of the black portion medianly concave; thorax and head with long dense pile, that of thorax golden-yellow; pile of metapleura largely yellow, but with some dark brown pile posteriorly. (Colorado) ..... **hirsutissima**

At least second tergite with posterior margin broadly black medianly, the yellow lateral spots, when present, abruptly cut-off at their inner margin 15

15. Median pale mark on fourth tergite in the form of an isolated narrow wedge which usually reaches more than halfway from posterior to anterior margin of segment; third segment usually also with a pale posteromedian spot; female with a large pale area surrounding the ocellar triangle on three sides; wings uniformly subhyaline; at least fore tibiae wholly yellow, rarely with partial brownish annulus. (Northeastern) ..... **norma**

Median pale mark on fourth tergite, if present, seldom attaining middle of segment; female with a small pale spot, not more than one-fourth width of front, before ocellar triangle 16

16. Pattern of venter as figured (fig. 17), ventrites four and five extensively yellow laterally and posteriorly, the black always with oblique lateral margins; pattern of abdominal dorsum at most with broad yellow lateral border on tergites two and three and narrow median longitudinal bar on tergite five (when pattern is this extensive, the ventral pattern is also extensive, so that only a small amount of black remains anteromedianly on ventrites three to five); never with median marking on tergite four; scutellum black, pale only between spines; metapleural pile white to yellow. (West to Colorado) ..... **meigenii**

Pattern of venter with less yellow on ventrites four and five, these segments usually largely or wholly black, the black color squarely truncate laterally and sometimes narrowed medianly by the yellow posterior margin of the ventrites being widest at that point; fourth tergite sometimes with posteromedian pale marking or with entire pale margin; scutellum frequently largely yellow; metapleural pile pale or dark 17

17. Metapleural pile dark brown to black 18

Metapleural pile wholly white, gray, or yellowish 22

18. Thoracic dorsum with pile dense and pale, grayish or yellowish, sometimes with black pile above wing bases 19

Thoracic dorsum with pile short, some in presutural area black; wings strongly infumated 21

19. Wings brownish, paler at apex; tarsi usually uniformly yellowish; male abdomen with transverse apical markings on tergites two and three and sometimes four and lateral margins of tergites three and four yellow;. female with a conspicuous yellow triangle on each side of the face; mesonotal pile of female cinereous to pale yellow, of male pale to deep reddish yellow, usually the latter, and with area of blackish pile above wing bases; scutellar spines erect. (South-central United States) ..... **browni**

Wings slightly and uniformly infuscated; tarsi yellow, usually becoming brownish toward apices; second abdominal tergite in both sexes with a large quadrate spot on each side,[2] the third with a complete or incomplete lateral margin and sometimes an apical transverse marking on each side; mesonotal pile cinereous to yellowish, rarely reddish yellow; scutellar spines not noticeably erect. (Rocky Mountain region and Northwestern) 20

20. Abdomen no broader than thorax, rather strongly convex in transverse section; mesonotal pile cinereous; third tergite without transverse apical markings ..... **griseata**

Abdomen distinctly broader than thorax, only moderately convex; mesonotal pile yellowish; third tergite sometimes with transverse apical or even broad lateral markings ..... **discaloides**

21. Second and third tergites with transverse yellow bars in posterior corners; tibiae yellow. (Illinois to Texas) ..... **jamesi**

Second tergite with squarish yellow lateral spot occupying full length of segment; tibiae black except proximal third. (Florida) ..... **floridensis**

22. Second ventrite largely pale, with narrow markings at anterior margin only; third ventrite with anteromedian black spot with rather roundish margin and extending at most a little more than halfway to lateral margin; fourth ventrite largely black, but with a little more yellow laterally than fifth ventrite (figs. 11 and 12); scutellum yellow only at apex. (Ohio; New York; Michigan) ..... **ohioensis**

Second ventrite extensively black; third ventrite also largely black, the color extending well over halfway to lateral margin 23

23. Scutellum narrowly yellow only at apex; second tergite with rather narrow transverse posterolateral yellow bar, a narrow lateral margin, and a small spot on anterior corner, remainder of dorsal pattern only slightly developed; ventrites with quite narrow posterior yellow margins, slightly wider medianly; wings subhyaline ..... **nigriventris**

Scutellum *usually* black only at base; second tergite nearly always with broadly triangular or subquadrate lateral marking; dorsal abdominal

[2]A melanic specimen of *S. griseata* Curran (Calgary, Alta., in Canadian National Collection) has the spot on second tergite reduced to broad margin and apex.

pattern quite various, frequently with posteromedian spots or complete pale margin on tergites three and four; ventral pattern consisting of yellow posterior margins rather equally developed on segments two to five, sometimes somewhat broader medianly, and a little more extensive on the second segment; wings usually subhyaline, sometimes (*S. senaria* Loew) rather deep brown, but paler apically and posteriorly; a widespread and complex species which apparently has developed several subspecies ..... **normula**

Stratiomys laticeps Loew

Stratiomyia laticeps Loew, 1866, Berliner Entom. Zeits. 10: 12 (Centuria VII, 20).
?*Stratiomys nymphis* Walker, 1849, List Dipt. Brit. Mus. 3, p. 530.
Stratiomyia laticeps Loew, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 234.
Stratiomyia occidentis Banks, 1926, Psyche 33: 42 (new synonymy).
Stratiomys occidentalis Banks, Curran, 1927, Trans. Roy Soc. Canada (v, 3) 21: 200 (*lapsus vel emendatione*); James, 1936, Jour. Kansas Entom. Soc. 9: 36.
Stratiomys laticeps Loew, Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 201; James, 1936, Jour. Kansas Entom. Soc. 9: 38.

A scarce but widespread species from the Hudson's Bay region to British Columbia and southward to California, Nevada, and Colorado.

Stratiomys maculosa Loew

Stratiomyia maculosa Loew, 1866, Berliner Entom. Zeits. 10: 12 (Centuria VI, 19), ♀.
Stratiomyia insignis Loew, 1872, Berliner Entom. Zeits. 16: 54 (Centuria X, 7), ♂.
Stratiomys dentata Bigot, 1879, Ann. Soc. Entom. France 16: 210.
Stratiomys lacerata Bigot, 1879, Ann. Soc. Entom. France 16: 211.
Stratiomyia maculosa Loew, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 241.
Stratiomyia maculosa Loew, Cole and Lovett, 1921, Proc. California Acad. Sci. (4) 11: 231.
Stratiomys maculosa Loew, Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 202.
Stratiomys maculosa Loew, James, 1936, Jour. Kansas Entom. Soc. 9: 37.

A large and striking form whose center of distribution is apparently in California, where all the types were found, but which also occurs as a common species in Oregon, Washington, Utah, and Idaho.

Stratiomys barbata Loew

Stratiomyia barbata Loew, 1865, Berliner Entom. Zeits. 9: 133 (Centuria VI, 9).
Stratiomys calopus Bigot, 1887, Ann. Soc. Entom. France 38: 23.
Stratiomyia barbata Loew, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 231.
Stratiomyia atra Cole, 1919, Proc. California Acad. Sci. (4) 9: 223 (new synonymy).
Stratiomys barbata Loew, Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 201.

A common species in the West from the Pacific Coast (California to Alaska) eastward to New Mexico, Colorado, and Manitoba. It has been recorded in the North from as far east as Nova Scotia, but such records may be erroneous, since this species may be confused with *S. obesa* Loew (*S. lativentris* Auctt.). However, a male specimen from Bathurst, New Brunswick (Canadian National Museum) is referred here; it has the pale integument a little more extensive than in western specimens, the fifth tergite having lateral marks, but the hair is largely black and the specimen is otherwise very similar to Rocky Mountain males.

Stratiomys atra represents a melanic variation.

Stratiomys badia Walker

Stratiomys badius Walker, 1849, List Dipt. Brit. Mus. 3, p. 529; 4, p. 1157.
Stratiomys ischiaca Harris, 1835, Cat. Ins. Massachusetts, 2d ed. (*nomen nudum*).
Stratiomyia picipes Loew, 1866, Berliner Entom. Zeits. 10: 13 (Centuria VII, 21).
Stratiomyia badius Walker, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 243.
Stratiomys badius Walker, Curran, 1927, Trans. Roy. Soc. Canada, (v, 3) 21: 202.
Stratiomys badia Walker, James, 1936, Jour. Kansas Entom. Soc. 9: 36.

Common in Canada westward to Alberta and has been seen from British Columbia; southward to New York, New Jersey, Ohio, Illinois, Wisconsin, and Colorado.

Stratiomys bruneri Johnson

Stratiomyia bruneri Johnson, 1895, Trans. Amer. Entom. Soc. 22: 233.
Stratiomys bruneri Johnson, Curran, 1927, Trans. Roy Soc. Canada (v, 3) 21: 201.

An uncommon species originally described from South Dakota; recorded by Curran from Manitoba and Alberta; and seen by us also from Utah, North Dakota, Wisconsin, Michigan, Minnesota, Saskatchewan, and the Northwest Territories (Nyarling River).

Stratiomys currani James

Stratiomys currani James, 1932, Amer. Mus. Novitates no. 571, p. 5; 1936, Jour. Kansas Entom. Soc. 9: 38.

An uncommon species recorded from Colorado, Idaho, Wyoming, Montana, Utah, Nevada, California, Oregon and Saskatchewan.

Stratiomys melastoma Loew

Stratiomyia melastoma Loew, 1865, Berliner Entom. Zeits. 9: 134 (Centuria VI, 10).
Stratiomyia melanostoma Loew, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 232.
Stratiomys melanostoma Loew, Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 201.
Stratiomys melanostoma Loew, James, 1936, Jour. Kansas Entom. Soc. 9: 36.

A moderately common form from Colorado west to California and north to British Columbia.

Stratiomys obesa Loew

Stratiomyia obesa Loew, 1865, Berliner Entom. Zeits. 9: 134 (Centuria VI, 11).
Stratiomyia lativentris Loew, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 233. (*non* Loew, 1865; misdetermination).

Since Johnson erroneously synonymized *S. obesa* with *S. lativentris*, other writers have followed him in applying the latter name to a common species. The true *S. obesa*, as shown by type examination, is a species which occurs abundantly in the Northeast, south to New York, Ohio, Indiana, and Illinois, and west to Nebraska and Saskatchewan.

Stratiomys lativentris Loew

(Fig. 18)

Stratiomyia lativentris Loew, 1865, Berliner Entom. Zeits. 9: 132 (Centuria VI, 8); *non* Auctt.

Examination of the type shows that this species is a rare one which we have seen only from Barnston, Lake Superior (type); Godbout, Quebec; Chippewa County, Berrien County, and Isle Royale, Michigan; Old Forge, New York; and Fulton Twp., Ontario.

Stratiomys discalis Loew

(Figs. 1–3, 7, 8, 13)

Stratiomyia discalis Loew, 1865, Berliner Entom. Zeits. 9: 136 (Centuria VI, 14).
Stratiomyia discalis Loew, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 240, (*partim*).
Stratiomys discalis Loew, Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 202, (*partim*).
Stratiomys media James, 1933, Jour. Kansas Entom. Soc. 6: 67 (new synonymy).
Stratiomys discalis media James, 1936, Jour. Kansas Entom. Soc. 9: 38 (new synonymy).

A moderately common species from Quebec and Ontario to New York, Ohio, Illinois, Colorado, and Wisconsin. James has determined from examination of the Loew type that his *S. media*, is a synonym and that the form that Johnson, Curran, *et al.*, had included with it requires a new name (*v.i.*). Besides the color characters cited in the key the shape of the head as shown in figures 1 to 3 and 7 and 8 is distinctive: in the male the lowest part of the sides of the mouth does not extend far below the eye and is well anterior to the lowest part of the eye, while in the female the reverse conditions obtain.

Stratiomys adelpha Steyskal, new species

(Figs. 4–6, 9, 10, 14–16)

Stratiomyia (*vel Stratiomys*) *discalis* auctt., *pro parte, non* Loew.

When James described *S. media* (*v. s.*) he was under the erroneous impression that this larger, somewhat differently shaped and colored form was *S. discalis*. Later examination of the Loewian type disclosed the necessity for a new name, which is here furnished. The form is distinguished from *S. discalis* as in the key. It is larger than *S. discalis* (12.2 to 14.2 mm. in body length), has a differently shaped head (figs. 4–6, 9–10), the base of the hind femora is always brown or yellow for at least a quarter of the length of the femur, and the second ventrite has at least a small black triangle in the posterior corners. The second ventrite (as in couplet 10 of the key and in figures 14–16) may be more extensively black due to increase in extent of the black posterior corners and the development of a black anteromedian spot, but the segment always has, at least in the material examined, a yellow portion remaining in the middle. The head in the male has the lowest part of the sides of the mouth well below the lowest part of the eyes and almost directly below that part; in the female the side of the mouth is less extended downward and the lowest point is well anterior to the lowest part of the eye, the opposite of the conditions in *S. discalis*.

As noted below, the species ranges through the same area as that cited for *S. discalis*. It is of comparable abundance with *S. discalis*, and is, in Michigan at least, found in the same habitats. I consider *S. adelpha* a sibling species, in the sense of Mayr, with *S. discalis*.

Types.—*Holotype* female, Three Rivers, St. Joseph County, Michigan, May 31, 1941; *allotype* male, Hemlock, Saginaw County, Michigan, June 1, 1940 (both collected by George C. Steyskal, and deposited in the collection of Maurice T. James). Material from the following

localities, including some specimens which have been labeled *paratypes*, has also been examined: QUEBEC (Carillon; Montreal; Rigaud); NEW YORK (Ithaca; Staten Is.); PENNSYLVANIA (Philadelphia); MICHIGAN (Alger, Berrien, Branch, Calhoun, Chippewa, Gladwin, Grand Traverse, Ingham, Kalkaska, Livingston, Oakland, St. Joseph, Washtenaw, and Wayne Counties); OHIO (Columbus; Delaware County; Hocking County; Sandusky); ILLINOIS (Algonquin; Rock Creek Park; Savannah; Stratford); WISCONSIN (Madison); MINNESOTA (Cass County; Garrison; Grand Rapids; Hennepin County; Itasca Park; Lake County; Lake Pepin; Lakeland; Minneiska; Plummer; Ramsey County; St. Anthony Park; Traverse County); UTAH (Eureka; Logan; Provo); IDAHO (Moscow); WASHINGTON (Pullman; Wawawai); TEXAS (Canadian).

Stratiomys hulli Steyskal, new species

Female.—Length of body, 13 mm. Head black, rather broad cuneiform facial orbits, narrow lower occipital orbits, moderate-sized cordate preocellar spot, and two small spots (as large as an ocellus) laterad of posterior ocelli, yellow. Distance from lowest part of eye to lowest part of side of mouth 0.375 total eye-height; lowest part of side of mouth only moderately in advance of vertical axis of eye. All hair of head pale yellowish.

Thorax black, with only the lower apex of the scutellum and the scutellar spines, which are almost perpendicular to the thoracic dorsum, yellow. The thorax is covered with rather dense pile which is whitish below and on the sides and yellow on the dorsum. The only dark-colored (black) hairs on the thorax are those of the metapleura and some at the fold of the squamae.

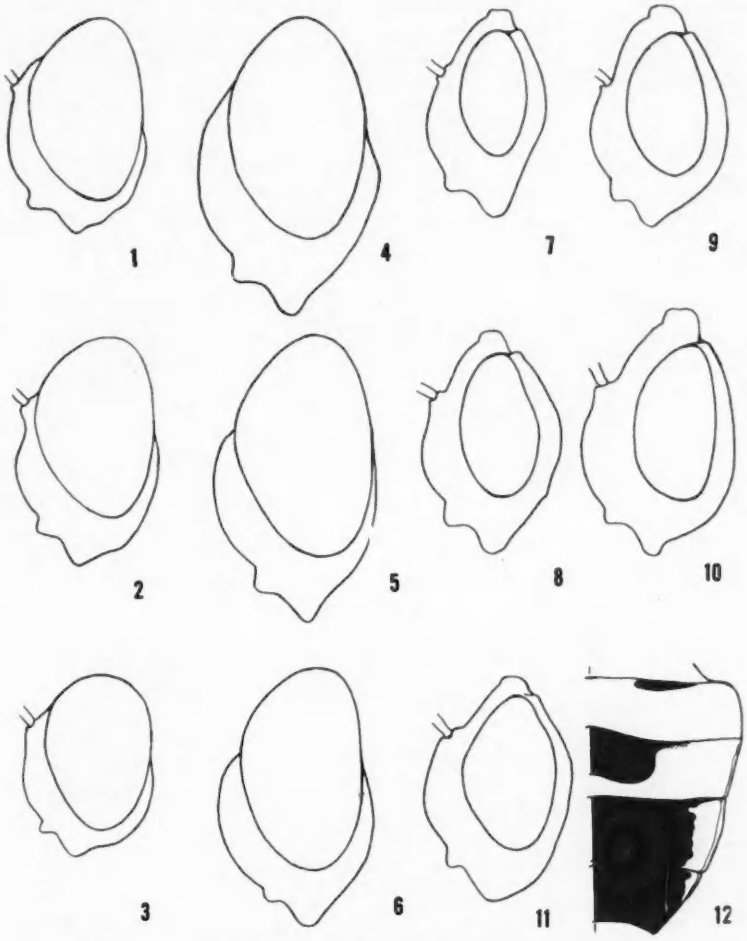
Legs with femora brown in basal half, black in apical half, except yellow knees. All tibiae and tarsi yellow, but the fore tibiae somewhat brownish in apical half and middle tibiae with indistinct median brownish annulus.

Wings dark brown, pale apically and posteriorly.

Abdomen strongly convex, black, and shining, with a very narrow continuous lateral yellow margin on segments two to four both dorsally and ventrally. Anterior corner of tergite three with a very small triangular extension of the yellow margin. Tergite five with narrow median longitudinal bar which does not extend to either the anterior nor the posterior margin. Venter very largely black, except lateral margin mentioned above, very narrow posterior margin of ventrite three, and posterior one-fourth of ventrite two, which is also narrowly yellow anteromedianly. Hair of abdominal dorsum short, whitish, and inconspicuous. There are some longish white hairs at the base of tergite two and some difficultly discernible black hairs at base of tergites three and four. All hairs of venter rather short and pale yellowish.

Type.—*Holotype* female, Agricultural and Mechanical College, Mississippi, April 15, 1920 (F. M. Hull), in collection of Ohio State University.

This form is close to *S. browni* Curran, but the entire lack of black hair on the head and the thoracic dorsum and the very much reduced abdominal pattern preclude identification with that species.



FIGS. 1–10. Left profile of head of *Stratiomys* species: 1, *Stratiomys discalis* Loew, male, Ann Arbor, Michigan; 2, *idem*, Lapeer County, Michigan; 3, *idem*, Hemlock, Michigan; 4, *Stratiomys adelpha* Steyskal, new species, male, Whitefish Point, Michigan; 5, *idem*, Hemlock, Michigan; 6, *idem*, Lake County, Minnesota; 7, *Stratiomys discalis* Loew, female, Ann Arbor, Michigan; 8, *idem*, Detroit, Michigan; 9, *Stratiomys adelpha* Steyskal, new species, female, St. Anthony Park, Minnesota; 10, *idem*, Nottawa, Michigan.

FIGS. 11–12. *Stratiomys ohioensis* Steyskal, new species, holotype: 11, left profile of head; 12, pattern of left half of venter.

Stratiomys hirsutissima James

Stratiomys hirsutissima James, 1932, Amer. Mus. Novitates no. 571: 1; 1936, Jour. Kansas Entom. Soc. 9: 36.

A rare species known only from the female type from Alamosa, Colorado.

Stratiomys nevadae Bigot

Stratiomys nevadae Bigot, 1887, Ann. Soc. Entom. France 39: 24.
Stratiomyia nevadae Bigot, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 237.
Stratiomys nevadae Bigot, Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 199.

An uncommon western species, described from Nevada and recorded by Johnson from Weber Lake, California. We have seen specimens from Tower City, North Dakota; Fox Park, Lone Tree, Evanston, Bridges Basin, Grand Teton National Park, and Yellowstone National Park, Wyoming; Boulder and Lay, Colorado; Logan Canyon and Park City, Utah; Victor and Paris, Idaho; Carson City, Nevada; Beaverlodge, Medicine Hat, Lethbridge, and Banff, Alberta; and Kamloops, British Columbia.

Stratiomys norma Wiedemann

Stratiomys norma Wiedemann, 1828, Aussereuropäische Zweiflügelige Insekten, 2, p. 62.
Stratiomyia quadrigemina Loew, 1865, Berliner Entom. Zeits. 9: 129 (Centuria VI, 3) (new synonymy).
Stratiomyia norma Wiedemann, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 236; Hart, 1896, Bull. Illinois State Lab. Nat. Hist. 4: 249; Malloch, 1917, Bull. Illinois State Lab. Nat. Hist. 12: 319; Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 204.

A common and easily recognized species in the Northeast from Quebec and Ontario to Pennsylvania, Illinois, Kansas, and South Dakota. *S. quadrigemina* is but a slight color variation, as Loew stated, "simillima Strat. normae Wied."

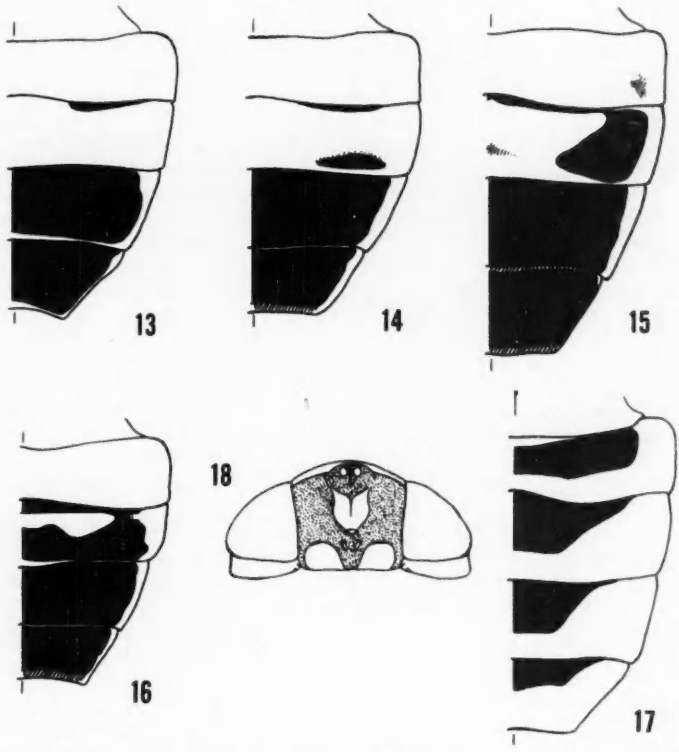
Stratiomys meigenii Wiedemann

(Fig. 17)

Stratiomys meigenii Wiedemann, 1828, Aussereuropäische Zweiflügelige Insekten, 2, p. 61.
Stratiomys robusta Walker, 1854, List Dipt. Brit. Mus., Suppl. 1, p. 37; (Johnson, 1895, Trans. Amer. Entom. Soc. 22: 247, description copied) (new synonymy).
Stratiomyia angularis Loew, 1865, Berliner Entom. Zeits. 9: 138 (Centuria VI, 16).
Stratiomyia marginalis Loew, 1865, loc. cit., no. 17.
Stratiomyia meigenii Wiedemann, Johnson, 1895, Trans. Amer. Entom Soc. 22: 238; 1913, Bull. Amer. Mus. Nat. Hist. 32: 49.
Stratiomyia meigenii Wiedemann, Malloch, 1917, Bull. Illinois State Lab. Nat. Hist. 12: 320.
Stratiomys meigenii Wiedemann, Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 203.
Stratiomys rubra James, 1933, Jour. Kansas Entom. Soc. 6: 68 (new synonymy).
Stratiomys (*vel Stratiomyia*) *quaternaria* Auctt., *non* Loew.

Common in the East from Quebec and Ontario to Georgia, Texas (Travis County), Kansas, Colorado, Iowa, and Wisconsin. Johnson (1913) has also recorded it from Biscayne Bay, Florida. Some of the synonymy noted above requires explanation: Information received through the kindness of Mr. Oldroyd makes the synonymy of *S. robusta*

with *S. quaternaria* Auctt. (Johnson, Curran, James) a practical certainty; as shown by the abdominal pattern, *S. robusta* Walker (*S. quaternaria* Auctt. *non* Loew) is but a light-colored variant of *S. meigenii;* examination of the types of *S. angularis* and *S. marginalis* confirms the synonymy that Johnson has already stated; *S. rubra* is apparently based on a teneral specimen of *S. meigenii.*



FIGS. 13–16. Pattern of left half of venter of *Stratiomys* species: 13, *Stratiomys discalis* Loew, female, Detroit, Michigan; 14, *Stratiomys adelpha* Steyskal, new species, female, Dynamite Pond, Ramsey County, Minnesota; 15, *idem*, Nottawa, Michigan; 16, *idem*, Ramsey County, Minnesota. FIG. 17. *Stratiomys meigenii* Wiedemann: left half of venter of female with melanic dorsal pattern, Detroit, Michigan. FIG. 18. *Stratiomys lativentris* Loew; dorsal view of head of female.

Stratiomys browni Curran

Stratiomys browni Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 203.
Stratiomys beameri James, 1933, Jour. Kansas Entom. Soc. 6: 66 (new synonymy).

An uncommon form described from Payne County, Oklahoma, and Cowley County, Kansas, respectively. We have seen material from Lawrence County, Ohio; Douglas County, Kansas; Gulfport and A. and M. College, Mississippi; Baton Rouge, Louisiana (December);

Stillwater and Ardmore, Oklahoma; and Dallas, College Station, Eastland County, and Madison County, Texas, most records being for April and May. Sufficient variation in color of scutellum and abdominal pattern is present, as already intimated in the Curran description, to bring *S. beameri* into conspecificity. James notes, after re-examining the type of *S. beameri*, "there is no yellow spot at the base of the antenna; it is merely the conjunctival membrane which is yellow."

Stratiomys griseata Curran

Stratiomyia velutina Curran, 1923, Canadian Ent., 54: 283; *non* Bigot, 1877.
Stratiomyia griseata Curran, 1923, Canadian Ent., 55: 74; 1927, Trans. Roy. Soc. Canada, (v, 3) 21: 202.

An uncommon species, described from British Columbia. We have seen material from Kamloops, British Columbia; Calgary, Alberta; Paulina Lake, Oregon; Moscow, Idaho; Darby, Bozeman, and Gallatin Co., Montana; Yellowstone National Park, Wyoming; and Spanish Fork and Provo Canyon, Utah; Late May to early July, or locally, later.

Stratiomys discaloides Curran

Stratiomys discaloides Curran, 1923, Canadian Ent., 54: 281; 1927, Trans. Roy. Soc. Canada (v, 3) 21: 202.

An uncommon species, described from British Columbia. We have seen material from Moscow, Idaho; Hamilton, Crazy Mts., and Harlan Gulch, Montana; Grand Teton National Park, Wyoming; Sonora Pass, Tuolumne Co., California; Duchesne and Willow Creek, Utah; and Pagosa Springs and McCoy, Colorado; late May to mid June.

Stratiomys jamesi Steyskal, new species

Male and *female*.—Length of body, 11–13 mm.

Head black, female with rather broad, wedge-shaped facial orbits, lower posterior orbits, a moderate ante-ocellar spot, and a small spot on each side of ocellar triangle, yellow; head of male wholly black, except trace of yellow on lower orbits. All hair of head yellowish. Cheeks very narrow, lateral oral lobe almost directly below vertical axis of eyes.

Thorax black, except scutellum, which is largely yellow. Female with hair of thorax largely golden yellow, short and inconspicuous; hair above base of wings, before scutellum, and laterally before transverse suture, black. Hair of metapleura and pteropleura also dark brown to black. Male with hair finer and more erect, similarly colored to that of the female, but the pale hairs almost white. Wings rather strongly infumated with rich brown color, but somewhat paler at apex and posteriorly. Legs with femora black, but becoming brown or even yellowish in basal half and distinctly yellow at knees; remainder of legs yellowish, except that fore and middle tibiae have a tendency to be brownish in the apical half.

Abdomen as narrow as thorax, strongly convex transversely; rather dull (as is thorax also) due to densely spaced tubercular hair-bases. Color of abdomen black with the following yellow pattern on dorsum: narrow lateral margins of tergites 3 and 4; posterolateral bars

on tergite 2 occupying somewhat less than half the length of the segment, extending approximately half-way to meson, and a little broader mesally; similar bars on tergite 3, but extending a little farther mesad and somewhat broader mesally; well-developed median longitudinal bar on tergite 5; sometimes a posteromedian spot on tergite 4. The yellowish lateral margin of tergite 3 is usually practically interrupted in the middle. One paratype (Austin, Texas) has the bars of tergites 2 and 3 strongly widened mesally, has a continuous posterior yellow margin on tergite 3, and the median spot of tergite 4 present and extending in a point forward almost to the middle of the tergite. The pattern of the male is less extensive than that of the females but is of the same type. Venter black, with rather short pale hairs and the following yellow pattern: narrow lateral margin of ventrites 2, 3, and 4 (also ventrite 5 in the male and some of the paratypes); ventrite 2 with narrow anterior margin and broad posterior margin, somewhat wider mesally so that the black is almost interrupted on the meson; ventrite 3 with narrow pale posterior margin a little wider mesally; ventrite 4 without or with very narrow posterior pale margin, also wider mesally (male with the posterior margin of ventrite 4 wider than any of the females and with the posterior margin of ventrite 5 also pale).

Types.—*Holotype* female, Madison County, Texas, August 15, 1930 (Bibby and O'Dowd), in University of Michigan Museum of Zoology; *allotype* male, Van Buren, Ozark Mountains, Missouri, July 9, 1930 (E. A. Pence), in University of Michigan Museum of Zoology; *paratypes*, females, Douglas County, Kansas, 900 feet (F. H. Snow), in Maurice T. James collection; Austin, Texas, June 26, 1923, reared from larvae in mud (Painter), in Maurice T. James collection; Labette County, Kansas, August 9, 1915 (R. H. Beamer); and Bourbon County, Kansas, 800 feet, 1915 (R. H. Beamer), in University of Kansas; Camp Drake, Catlin, Illinois, June, 1939, in Illinois Natural History Survey collection.

This species and *S. floridensis*, which may be but a subspecies, form a small group not closely related to others. The relationships and the distinctions between the two forms may be gleaned from the key.

Stratiomys floridensis Steyskal, new species

Female.—Length of body, 14 mm.; of wing, 12 mm. A large, dark form, black with only the following parts yellow: round, ante-ocellar spot, extending halfway to antennal bases; small, indistinct areas laterad of ocellar protuberance; facial orbits; very narrow stripe on lower posterior orbits; scutellum, except rather narrow base dorsally and laterally; extreme tip of all femora and basal third of all tibiae; middle and hind tarsi (fore tarsi dark brown); large subquadrate mark at each side of second abdominal tergite, as broad posteriorly as length of tergite and somewhat narrower anteriorly; traingle in anterior corners of third tergite and small part of lateral and posterior margins of tergite, black color extending to lateral margin in middle; very small longitudinal mark in center of fifth tergite; approximately posterior third of second ventrite, the color extending along lateral margins of ventrite in same width; entire lateral margin of third ventrite, extending inward along posterior margin to form triangle.

Pile of face and frontal orbits whitish; pile of remainder of front and occiput black. A patch of white hairs at lower corner of eye and a stripe of white tomentum on upper posterior orbits. Pile of thorax black and short; that of sternum, broad band extending across middle of mesopleura to ends of transverse suture of mesonotum, and patch of long hairs on lower propleura, whitish ventrally and yellowish dorsally. Anterior two-thirds of presutural mesonotum with short, recumbent grayish yellow pile, interrupted medianly and not extending to margins or to humeri. Postalar calli with patch of long white pile. Hairs of yellow part of scutellum also pale. Hairs of abdomen in great part black; a small area in anterior corners of fifth tergite with whitish hairs and some inconspicuous areas of whitish hairs in middle of abdominal dorsum. Hairs of tibiae, tarsi, and anterior basal part of fore femora white or yellowish.

Halteres with yellow stem and green knob.

Wings wholly deep brown, the heavy veins and basal sclerites black.

Length of antennal segments from base as 5.3, 1, 8.7; antennae wholly black in color.

Entire thorax and abdomen rough owing to minute, semiglobose warts at base of hairs.

Type.—*Holotype* female, Tallahassee, Florida, April 1, 1944 (R. and G. Bohart), in United States National Museum.

As shown in the key, this form is closely related to *S. jamesi*, of which it may prove to be but a subspecies.

Stratiomys ohioensis Steyskal, new species

(Figs. 11 and 12)

Female.—Length of body, 11–13 mm.

Head black, with rather narrow and parallel-sided facial orbits, narrow lower posterior orbits, a roundish ante-ocellar spot, and sometimes a pair of very small spots on each side of ocellar triangle, yellow. All hair of head whitish. Profile of head as in figure 11.

Thorax black, scutellum yellow only near apex between and including the spines. Hairs of thorax fine and erect, not dense enough to obscure color of integument, in color whitish except rather conspicuous patches of black hairs dorsally on each side anterior to transverse suture, above wing bases, before scutellum, and in two patches anteriorly behind head. Metapleural pile whitish or pale yellowish.

Wings only lightly and evenly infumated.

Legs with femora black except piceous basal half of hind pair and yellow extreme tip of all femora; with tibiae usually black except yellow basal third; and with tarsi either wholly yellowish or with apical two segments brownish.

Abdomen distinctly wider than thorax, strongly convex, practically as high as thorax in lateral view, and strongly declivitous on last two segments. Tergite 2 with rectangular yellow marks laterally occupying whole length of segment; tergite 3 with broad anterolateral triangles connected on lateral margin with small pointed inward extensions of yellow on posterior margin; tergite 4 with narrow triangle of yellow laterally pointing posterad and sometimes a very narrow and short extension of yellow inward on posterior margin; tergite 5 with median

longitudinal bar extending three-fourths of distance to anterior margin of segment.

Venter with rather short, coarse hairs, especially short on fourth and fifth ventrites, and with pattern as in figure 12, the black spot on ventrite 3 sometimes narrowly divided mesally and ventrite 4 sometimes also with a narrow yellow posterior margin.

Male.—Head in profile very similar to that of *S. discalis* (*cf.* figs. 1–3). Color of head wholly black with white hairs, except near and dorsad of base of antennae, where they are black.

Thorax with hair long and fine, not especially dense, grayish yellow generally in color, but with blackish patches similar to those of female. Metapleural pile yellowish, but with some blackish hairs near squamae.

Abdomen with dorsal yellow areas slightly more extensive than in female, and with somewhat longer pale yellowish hair ventrally.

Types.—*Holotype* female, Delaware County, Ohio, May 30, 1939 (C. H. Kennedy), in Ohio State University; *allotype*, male, Ithaca, New York, July 15, 1935, Maurice T. James collection; *paratypes*, females, two, Ira, Summit County, Ohio (J. S. Hine), in Ohio State University; Champaign County, Ohio, June, 1931 (J. Patton), and Logan County, Ohio, July, 1931 (D. Murray), in University of Minnesota. Ithaca, New York, July 2, 1925, in Maurice T. James collection; Ionia County, Michigan, June 10, 1950 (R. R. Dreisbach), in Dreisbach collection.

This form is close to *S. discalis* Loew and *S. adelpha*, new species, especially the former, from which it differs, as shown in the key, by the ventral pattern, shorter ventral hair, and somewhat different profile of head.

Stratiomys nigriventris Loew

Stratiomyia nigriventris Loew, 1865, Berliner Entom. Zeits. 9: 137 (Centuria VI, 15).

? *Stratiomyia meigenii* Wiedemann, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 239 (*partim*).

Loew described this form on the basis of a female from Nebraska. Johnson mentions it under *S. meigenii* only in the following sentence: "The type of *S. angularis* differs from *S. marginalis* in having more prominent yellow triangles at the anterior angles of the segments, and *S. nigriventris* in having a greater amount of black on the ventral segments." The name was omitted from the Aldrich Catalogue, and has been otherwise neglected since.

We believe that the form should be recognized as a distinct species, separable as in the key. It is close to *S. meigenii*, but that species, even when the dorsal abdominal pattern is very reduced, still has broad lateral yellow zones on the venter. We have seen a specimen from West Point, Nebraska, and one labeled in longhand "Texas Belf.," both females and both in the United States National Museum.

Stratiomys normula Loew

Several described forms appear to be best treated as subspecies of *Stratiomys normula*. These forms may be separated in most cases as in the following key.

KEY TO THE SUBSPECIES OF *Stratiomys normula* LOEW

1. Wings rather strongly infumated; fourth tergite with posteromedian triangle or with continuous yellow margin. (Florida) ..... **normula senaria**
   Wings subhyaline, but lightly infumated with brownish color 2
2. Fourth abdominal tergite usually with (sometimes without) transverse lateral bars, and with or without a posteromedian pale triangle. (Eastern and Northern) ..... **normula normula**
   Fourth tergite with continuous pale posterior margin. (Western) 3
3. Third tergite with transverse lateral bars, but lacking median pale marking .. .. **normula unilimbata**
   Third tergite with median marking 4
4. Third tergite with median triangle, lateral pale marking strong .... **normula wyomingensis**
   Third tergite with continuous pale posterior margin .... **normula angulicincta**

Stratiomys normula normula Loew

Stratiomyia normula Loew, 1865, Berliner Entom. Zeits. 9: 130 (Centuria VI, 5).
Stratiomyia quaternaria Loew, 1865, *op. cit.*:135 (Centuria VI, 12) (new synonymy).
Stratiomyia apicula Loew, 1865, *op. cit.*: 136 (Centuria VI, 13), ♀ (new synonymy).
Stratiomyia notata Loew, 1865, *op. cit.*:139 (Centuria VI, 18).
Stratiomyia normula Loew, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 235.
Stratiomyia apicula Loew, Johnson, 1895, *op. cit.*: 239.
Stratiomys apicula Loew, Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 203; as *S. normula apicula* in key, p. 201.
Stratiomys normula Loew, Curran, 1927, *op. cit.*: 204.
Stratiomys apicula Loew, James, 1936, Jour. Kansas Entom. Soc. 9: 38.

This form is abundant in the Northeast and extends westward to British Columbia and Colorado, and southward to Kansas, Nebraska, Illinois, and South Carolina. James has found from examination of the type that *S. **quaternaria*** is a synonym of *S. **normula***. What Johnson and those following him have considered as *S. **quaternaria*** is a form which we are treating as a variant of *S. **meigenii*** (*q.v.*). We are considering *S. **apicula*** to be merely a phenotypical variant characterized by the lack of the posteromedian triangle on the fourth abdominal tergite.

Stratiomys normula senaria Loew

Stratiomyia senaria Loew, 1865, Berliner Entom. Zeits. 9: 132 (Centuria VI, 7).
Stratiomyia senaria Loew, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 237; 1913, Bull. Amer. Mus. Nat. Hist. 32: 49.
Stratiomyia unilimbata Loew Johnson, 1913, *loc. cit.*

A scarce form, thus far found only in Florida. It sometimes has a complete yellow posterior margin on the fourth abdominal tergite. It is then distinguishable from *S. n. **unilimbata*** only by the deeper brown color of the wings. I have examined such specimens from Biscayne Bay, Florida, determined by Johnson as *S. **unilimbata***.

Stratiomys normula unilimbata Loew

Stratiomyia unilimbata Loew, 1865, Berliner Entom. Zeits. 9: 131 (Centuria VI, 6).
Stratiomyia unilimbata Loew, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 236.
Stratiomys unilimbata Loew, Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 204.
Stratiomys jonesi James, 1932, Amer. Mus. Novitates no. 571, p. 4 (new synonymy).
Stratiomys unilimbata Loew, James, 1936, Jour. Kansas Entom. Soc. 9: 38.
Stratiomys unilimbata jonesi James, 1936, *loc. cit.*

A western form occuring rather commonly in the Great Plains, west to Alberta, east to Michigan, and south to Colorado and Illinois.

For Johnson's record of *S. unilimbata* from Florida, see *S. n. senaria*, above.

Stratiomys normula angulicincta James

Stratiomys angulicincta James, 1932, Amer. Mus. Novitates no. 571, p. 3; 1936, Jour. Kansas Entom Soc. 9: 38.

A rare form known from Colorado, Utah, and New Mexico.

Stratiomys normula wyomingensis James

Stratiomys wyomingensis James, 1932, Amer. Mus. Novitates no. 571, p. 3; 1936, Jour. Kansas Entom. Soc. 9: 37.

A rare form from Wyoming, Montana, and North Dakota.

The following are still *species inquirendae*. Previous synonymy of some of them must be doubted, especially that of *S. diademata* with *S. maculosa* (Johnson, 1895) and that of *S. nymphis* with *S. laticeps* (Osten-Sacken). Johnson (1895, pp. 245–248) has copied the descriptions of *S. constricta*, *S. goniophora*, *S. nigrifrons*, *S. simplex*, and *S. pinguis*. Three of them (*S. constricta*, *S. goniophora*, and *S. pinguis*) may not fall within our range, since they were described from "Mexico."

Stratiomys constricta Walker, 1858, Trans. Entom. Soc. (London) (n.s.) 5: 268. Mexico.
Stratiomys diademata Bigot, 1887, Ann. Soc. Entom. France 39: 23. Georgia.
Stratiomys goniophora Say, 1829, Jour. Acad. Nat. Sci. Philadelphia 6: 161 (Complete Works 2: 356). Mexico.
Stratiomys lineolata Macquart, 1850, Dipt. Exot. (Mem. Soc. Sci. Arts de Lille), suppl. 4, p. 48.
Stratiomys nigrifrons Walker, 1849, List Dipt. Brit. Mus. 3, p. 531. Hudson's Bay.
Stratiomys nymphis Walker, 1849, *op. cit.*, p. 530. Hudson's Bay.
Stratiomys pinguis Walker, 1858, Trans. Entom. Soc. (London) (n.s.) 5: 270. Mexico.
Stratiomys simplex Bigot, 1887, Ann. Soc. Entom. France 39: 24. Texas; Colorado.

Genus **Labostigmina** Enderlein

1930, Deut. Entom. Zeit., 1930: 70; James, 1936, Trans. Amer. Entom. Soc., 62: 35, 36. Type, *Odontomyia occipitalis* Johnson.

KEY TO THE NEARCTIC SPECIES OF *Labostigmina*

1. Eyes densely and distinctly pilose 2
   Eyes bare 3
2. First antennal segment 2.5 to 3 times length of second; first and second antennal segments yellow; face only moderately protuberant; abdominal segments two to four with yellow posterior triangles, rarely with distinct bands ..... **flavicornis**
   First antennal segment not more than 1.5 times length of second; antenna black or the flagellum in part reddish; face strongly tuberculate; abdomen of female with a complete transverse yellow band each on segments three and four and with a similar but usually narrowly interrupted band on segment three ..... **viridis**
3. Venter largely black, or at least sterna four and five each with a black transverse band which extends at least over approximately the basal half of the segment 4
   Venter yellow or green, at most discolored other than in the above pattern, or without black markings or small black spots 10

4. Abdominal sterna three to five each with a black transverse band occupying approximately the basal half, sternum two with less extensive black markings; humeri yellow; a yellow, wedge-shaped spot sublaterally on each side of the mesonotum, before the suture; pile of body short, inconspicuous, mostly appressed ..... **novella**
Abdominal sterna otherwise marked, at least the fourth and fifth largely black (rarely merely discolored but retaining the same pattern); humeri, at least in part, black; sides of mesonotum before the suture black 5
5. Abdominal terga, except for narrow lateral margins, either wholly black or with narrow linear apical markings on segments two, three, and sometimes four; these markings may be, in the males, broader laterally but not extending more than half-way to the base of the respective segment, and roughly similar to one another, or, on the other hand, in the females, obscured laterally so as to leave only a pair of spots on segment two, and completely evanescent on the other segments 6
Second abdominal tergum, on each side, with a broad triangle which attains the base of the segment; third tergum with a narrow linear marking, definitely smaller and in marked contrast with that of the second 7
6. Antenna wholly black; face of male broad, the width across lower angle of eyes 0.6 head width; abdominal terga with conspicuous erect yellowish pile medially as well as laterally ..... male of **hypomelas**
First and second antennal segments yellow, the flagellum usually in part reddish; face of male relatively narrow, the width across lower angle of eyes not more than 0.5 head width; abdomen in both sexes practically devoid of long erect yellowish pile on disc of intermediate segments ..... **obscura**
7. First and second abdominal sterna wholly yellow 8
All sterna except sometimes second in large part black; antenna wholly black; scutellum of female black at base 9
8. Front smooth; scutellum of female wholly yellow; first and usually, also second, antennal segment yellow basally ..... **annamariae**
Front wrinkled longitudinally at middle; scutellum of female narrowly black at base; antennae wholly black ..... female of **hypomelas**
9. Second abdominal sternum with a large yellow area or wholly yellow ..... **megantica**
All abdominal sterna almost wholly black (male unknown) ..... **gagatigaster**
10. First antennal segment not more than 1.25 times length of second, the two usually subequal; chiefly Southwestern species 11
First antennal segment at least 1.5, usually at least 2.0, times length of second 13
11. Abdominal terga two to four black-haired medially ..... **micheneri**
Abdominal terga without outstanding black hairs 12
12. First and second antennal segments fulvous to yellow; scutellum of female wholly yellow or green; pale markings on abdominal terga 2 to 4 inclusively never forming complete posterior bands but sometimes forming uninterrupted lateral margins in the male ..... **fulvicornis**
Antenna wholly black, at least on basal segment; scutellum black with a narrow (male) to broad (female) apical and lateral greenish-yellow margin, or in rare cases the scutellum entirely greenish except that the basal median area shows evidences of pigmentation at least around bases of setulae; pale markings on abdominal terga 2 to 4 often in the form of complete transverse bands ..... **texasaina**
13. Vein M_3 vestigial, represented only by a spur from the discal cell and by a weak fold, visible only from certain angles; scutellum unusually short, less than 0.33 times as long as wide ..... **defecta**
Vein M_3 evident for nearly its entire length; scutellum of normal proportions for the genus, usually about 0.40 as long as wide 14
14. First and second antennal segments yellow; yellow markings of second abdominal segment nearly attaining base of segment 15
Antenna wholly black, or at most scape with some yellow below and at base 16
15. Mesonotum with erect pale hairs in addition to the dense tomentum; these hairs short in females, as long as first antennal segment in males;

abdominal pale tomentum (hard to see except with the correct angle and illumination) from anterior view, forming broad lateral margins on black as well as pale areas; wings yellowish-hyaline; male with dense erect pale pile on abdomen ..... **johnsoni**

Mesonotum of female without erect pile and with inconspicuous pale tomentum, that of male with pile distinctly shorter than first antennal segment; abdominal pale tomentum likewise inconspicuous and limited to pale spots and the immediately adjacent areas; wings reddish-hyaline, more noticeably so in females; pile of male abdomen sparse, at least on the disc ..... **rufipennis**

16. Pale markings of second abdominal tergum attaining base of segment or almost so; mesonotum of female usually with at least a small pale area before the suture on each side, often with complete pale lateral margins; species of the Eastern United States 17

Pale markings of second abdominal tergum confined to apical half of segment; mesonotum of both sexes wholly black before the suture; ratio of first to second antennal segments 1.5 : 1; pale markings of head and body tending to green or greenish-yellow in dried specimens; high-altitude species of the Rocky Mountains ..... **similis**

17. Pale markings of second abdominal tergum forming an isosceles triangle, the side along the lateral margin of the tergum being about equal to the side along its apex; first antennal segment about 2.0 times length of second, in the male about as long as the frontal or mesonotal pile; scutellum of female wholly yellow; pleura of male without extensive well-defined yellow areas ..... **hieroglyphica**

Pale markings of second abdominal tergum hardly triangular, more in the form of a broad lateral margin which is expended apically, and about 1.5 times as long as the apical width; first antennal segment about 2.5 times length of second, much longer than frontal or mesonotal pile in either sex; scutellum of female with a prominent black basal area; upper pleural areas of male distinctly yellow, these areas well-defined ..... **occipitalis**

Labostigmina flavicornis (Latreille)[3]

Odontomyia flavicornis Latreille, *in* Olivier, 1811, Encycl. Méth., viii, 433.
Stratiomys flaviceps Macquart, 1834, Suit. à Buffon, I, p. 245.
Stratiomys coronata Guérin, 1835, Icon. Regne Anim., vii Ins., tab. xcviii, fig. 6.
Stratiomys flavicornis (Olivier), Walker, 1854, List. Dipt. British Mus. 5 (Suppl. 1), p. 38.
Odontomyia lasiophthalma Loew, 1865, Berliner Entom. Zeits., 9: 142 (Centuria VI, 23).
Stratiomyia pulchella Macquart, 1838, Dipt. Exot. i, 1, p. 180.
Stratiomyia vicina Macquart, 1838, Dipt. Exot. i, 1, p. 181.
Odontomyia flavicornis Olivier, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 269.
Stratiomys flavicornis (Olivier), Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 201.
Labostigmina flavicornis (Olivier), James, 1936, Trans. Amer. Entom. Soc. 62: 36.

A widespread, though only moderately common species: Maine to Florida, westward through southern Ontario to Minnesota, Kansas, and Texas.

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[3]We are crediting the stratiomyid species of the Encyclopédie Méthodique to Latreille, rather than to Olivier, as most authors have done in the past, on the basis of the following statement by Olivier, tome vii, p. 468: "Nous avons engagé M. Latreille . . . à se charger dorenavant de quelques articles qui seront souscrits des trois premieres lettres de son nom." See Sherborn and Woodward, 1893, Proc. Zool. Soc. London, 1893: 582–584.

Labostigmina viridis (Bellardi)

Odontomyia viridis (Bellardi), 1859, Saggio di Ditterologia Messicana, I, p. 36; Johnson, 1895, Trans. Amer. Entom. Soc. 22: 270.
Odontomyia snowi Hart, 1895, Bul. Illinois State Lab. Nat. Hist. 4: 256, 266 (new synonymy); Aldrich, 1905, Catal. North Amer. Dipt., p. 185 (synonymy with *hieroglyphica*, *fide* Johnson).
Odontomyia viridis (Bellardi), Curran, 1927, Trans. Roy. Soc. Canada, (v, 3) 21: 215.
Labostigmina viridis (Bellardi), James, 1936, Trans. Amer. Entom. Soc. 62: 36.

A moderately common species in Texas, Oklahoma, and Kansas, and extending northward to Indiana, Illinois, and South Dakota, and southward into Mexico.

In Aldrich's card catalogue at the United States National Museum, the following statement occurs: "Johnson somewhere said this is syn. of hieroglyphica. I have lost the ref. Malloch however says it is distinct, with eyes long-pilose, etc." Hart's brief description does not fit *hieroglyphica*, but does agree with *viridis*, particularly in regard to the coloration of the antennae, and Malloch's statement concerning the long-pilose eyes further suggests that synonymy, which we have been able to confirm through examination of the type of *snowi*.

Labostigmina novella Steyskal

Labostigmina novella Steyskal, 1938, Occ. Papers Mus. Zool. Univ. Michigan, 386, p. 1.

A rare species known only from the type series (Austin, Texas; Baboquivari Mountains, Arizona), and from an additional female from Ozona, Texas.

Labostigmina annamariae (Brimley)

Odontomyia annamariae Brimley, 1925, Entom. News, 36: 76.
Labostigmina annamariae (Brimley), James, 1936, Trans. Amer. Entom. Soc. 62: 36.

Described from a female from North Carolina, without locality. I have seen two males from Clemson College (O. L. Cartwright) and Liberty, North Carolina, (T. B. Mitchell), and thirteen males and seven females from Cheaha State Park, Alabama (Van Dyke). All specimens were taken in April. The male (previously undescribed) is very much like the female; the head is entirely black, except for a suggestion of yellowish behind the eyes; the thorax, including the scutellum and scutellar spines, is wholly black; and the pile of the entire body is longer and denser than in the female.

Labostigmina megantica (Curran)

Odontomyia megantica Curran, 1925, Canadian Entom. 57: 254; Trans. Roy. Soc. Canada (v, 3) 21: 213.
Labostigmina megantica (Curran), James, 1936, Trans. Amer. Entom. Soc. 62: 36.

A rare species recorded from Quebec and Ontario. We have an additional record from Newaygo County, Michigan, July 15, 1950 (R. R. Dreisbach).

Labostigmina gagatigaster Steyskal

Labostigmina gagatigaster Steyskal, 1949, Papers Michigan Acad. Sci., Arts & Letters, 33: 173 (1947).

A rare species, known only from the type series from Michigan.

Labostigmina hypomelas James, new species

Male.—Head wholly black except very narrow ocular and occipital orbits on lower half, which are yellowish; some black pile between the eyes and on the ocellar triangle, the remaining pile of the head pale; that at base of antennae erect, about length of first antennal segment; that on the face slightly shorter, rather dense. Antennae wholly black; ratio of length of scape, pedicel, and flagellum 24: 11: 49; last segment of flagellum very short. Labella broad.

Thorax and scutellum wholly black; spines of scutellum short, almost obsolescent. Pile for color and length as on face; densest on dorsum, where it is erect. Considerable pale tomentum on dorsum. Legs black; the very narrow apices of the femora, basal third of tibiae, and the tarsi, yellow, the three apical tarsomeres becoming blackish. Wings yellow, subhyaline, the strong veins brownish; vein r-m wanting. Halteres pale yellow.

Abdomen black marked with yellow; tergum 2, on each side, with a subtriangular marking which extends about two-fifths way to the base and less than one-fifth way across the apex of the segment; terga 3 and 4 each with a transverse linear marking on each side, that of tergum 4 being the smaller; tergum 5 with narrow lateral and apical margins. Sterna 1 to 3 yellow, except an irregular blackish marking on each side of 3; 4 and 5 black with yellow lateral and posterior margins. Pile as on the thorax; somewhat shorter on the sterna than on the terga. Genitalia brownish, appendages yellowish.

Length, 8.5–9.0 mm.

Female.—Front distinctly wrinkled longitudinally, four or five distinct folds being evident on each side. Front yellow; a transverse band on vertex, including the ocellar triangle, and an inverted W-shaped band (the two inner legs of the W sometimes obsolete) at middle of front, black; face and occiput black but the broad occipital and somewhat narrower facial orbits yellow; the facial orbits connect above with the yellow of the front and below with the occipital orbits, and send, on each side, an extension across the posterior part of the oral margin; anterior angles of oral margin yellow. Pile as in the male, but much shorter.

Humeri, supraalar calli, scutellum, except very narrow base, a prominent inverted U-shaped area on each mesopleuron beginning behind the coxa and ending at the sternopleuron, upper part of sternopleuron, and upper and posterior part of pteropleuron, yellow; pile of thorax similar to that of male, but much shorter, and tomentum of mesonotum somewhat denser. Abdomen with yellow marking of second tergum almost reaching base of segment and extending inwardly almost to median third, its inner margin concave; linear markings of third and fourth terga somewhat larger than respective markings of male. Otherwise as described for the male.

Types.—*Holotype* male, Austin, Texas, April 7, 1932. *Allotype* female, Brazos County, Texas, April 18, 1936 (R. K. Fletcher). *Paratypes:* male, Austin, Texas, April, 1931 (H. G. Parks); female, College Station, Texas, April 21, 1936 (R. K. Fletcher); male, Victoria, Texas, April 24, 1907 (F. C. Bishopp) on *Hymenopappus flavescens.*

Labostigmina obscura (Latreille)

Odontomyia obscura Latreille, *in* Olivier, 1811, Encycl. Méth., viii, p. 433.
Odontomyia brevipennis Latreille, *in* Olivier, 1811, Encycl. Méth., viii, p. 434.
Stratiomys obscura (Olivier), Walker, 1854, List Dipt. British Mus. 5 (Suppl. 1), p. 38.
Odontomyia obscura (Olivier) Johnson, 1895, Trans. Amer. Ent. Soc. 22: 270.
Labostigmina obscura (Olivier), James, 1936, Trans. Amer. Entom. Soc. 62: 36.

A common species in the southeast, from Kansas east to Virginia and south to Texas and Florida. We also have records from Madison, Wisconsin; Carlinville, Illinois; and Shawnee Forest, Ohio.

Labostigmina fulvicornis (Curran)

Odontomyia fulvicornis Curran, 1927, Trans. Roy. Soc. Canada, (v, 3) 21: 213.
Labostigmina fulvicornis (Curran), James, 1936, Trans. Amer. Entom. Soc. 62: 36.

A rare species described from a female from Oklahoma. We have records from Comanche County, Oklahoma; also, from Uvalde, Zavalla, and Dimmit Counties, and from Denton and Waxahachie, Texas.

Labostigmina texasiana (Johnson)

Odontomyia texasiana Johnson, 1895, Trans. Amer. Entom. Soc. 22: 259.
Odontomyia texana Johnson, Aldrich, 1905, Catal. North Amer. Dipt., p. 187 (*emendatione*).
Labostigmina texana (Johnson), James, 1936, Trans. Amer. Entom. Soc. 62: 36.

All our records are from Texas, but this species seems to be fairly common from Dallas and Waco southward to the lower Rio Grande Valley.

Labostigmina micheneri James, new species

Male.—Structurally close to *L. texasiana;* as in the male of that species the head, when viewed ventrally, has the lower ocular orbits nearly parallel; the second antennal segment is a little shorter in proportion to the first (ratio of first to second, 1.25 : 1) and the face is a little more strongly protuberant. First and second antennal segments, as well as first three segments of flagellum, reddish yellow; the terminal two flagellar segments black. Pile of head and especially of mesonotum longer than in *L. texasiana;* that of abdomen yellow on sides and apex, both the dense short hairs and the longer, more scattered ones on the median half of segments 2 to 4 inclusively, black. Scutellum black, the spines yellow-tipped; first abdominal tergum wholly black; the second with a yellow marking in the form of an isosceles right triangle, somewhat concave along its hypotenuse, along the entire lateral margin and apical corners; third with a very narrow margin but with an apical stripe on each side, comparable to the apical leg of the triangle on the second; fourth with the very narrow lateral margins and a slight extension of the color at the apex on each side; fifth very narrowly margined laterally, more broadly so apically. The abdominal color pattern is close to that of *L. johnsoni*, to which this species might trace in our key, but the black abdominal pile will readily distinguish the two. In *L. johnsoni* the ratio of the first antennal segment to the second is greater, about 1.5 : 1; the color of the flagellum changes gradually from yellowish basally to brownish apically; and the lower occipital orbits, when the head is viewed ventrally, are distinctly divergent.

Type.—*Holotype* male, Pulaski, Tennessee, April 14, 1946 (C. D. Michener). In the American Museum of Natural History.

Labostigmina defecta James, new species

Female.—Head greenish yellow except the following areas which are black: a band on the vertex, from eye to eye, including the ocellar triangle; a cuneiform spot on each side at middle of front, its blunt end inward, and with suggestions of connectives which would, if complete, form an inverted W; an area from lower front over antennal insertion to facial prominence, and a narrow streak extending from this area on each side to the oral margin, where it is contiguous with a stripe across middle of each side of oral margin; and the central part of the occiput. Pile of head short; black on vertex and upper part of front, otherwise yellow; antennae blackish, the scape and pedicel largely brownish to yellow; ratio of scape, pedicel and flagellum 2: 1: 4; last segment of flagellum very short. Proboscis black, slender, rigid.

Mesonotum black except supraalar calli and an area extending forward from each to a point about half way to the suture, which are greenish yellow; humeri and scutellum except very narrow base greenish yellow; middle of propleura, upper parts of mesopleura, pteropleura, upper parts of sternopleura and hypopleura, and lower parts of metapleura greenish yellow. Pile of thorax short, erect, yellowish, densest on the mesonotum where it is underlain by golden tomentum. Scutellum exceptionally short; ratio of width (excluding basal spinose projections) to length, 3: 1; spines short, almost evanescent. Coxae and femora black; apices of femora and bases of tibiae distinctly yellow; tibiae becoming brownish beyond basal third (hind tibia) to half (middle and front tibiae); tarsi yellowish, becoming brownish beyond basitarsi. Wings hyaline, somewhat infumated along costal margin, discal cell, and cubitus; vein M_3 represented only by a stump.

Halteres yellow, the knobs bright green. Abdomen black marked with greenish yellow; second tergum on each side with a posterior inwardly concave triangle which attains base of tergum laterally but does not extend to the median third along the apex; third and fourth terga each with a narrow rectangular marking on each side apically; broad apical and narrow lateral margins of fifth segment yellowish. Venter yellow. Terga with sparse black pile and tomentum medially, mostly pale pile and dense yellow tomentum laterally. Venter pale-pilose.

Length, 8 mm.

Male.—Head black; a very small yellowish area below facial prominence. Pile of face and lower front about length of first antennal segment; that of mesonotum likewise long and denser than in the female. Thorax including scutellum wholly black, only the scutellar spines yellow. Markings of abdomen yellow, those on terga similar to those of the female but slightly smaller. Genitalia yellow. Otherwise as described for the female.

Types.—*Holotype* female, *allotype* male, Baton Rouge, Louisiana, April 14, 1947 (W. W. Wirth); in the United States National Museum.

This species is closely related to *L. hieroglyphica* (Latreille) and *L. johnsoni* (Curran), from which it may best be distinguished by the key characters.

Labostigmina johnsoni (Curran)

Odontomyia johnsoni Curran, 1925, Canadian Entom. 57: 255; 1927, Trans. Roy. Soc. Canada (v, 3) 21:213.
Labostigmina johnsoni (Curran), James, 1936, Trans. Amer. Entom. Soc. 62: 36.

A common species from Texas eastward to Alabama and northward to Kansas (Caney) and Tennessee (Nashville). East of this area we have records from Washington, D. C., and nearby Bladenberg, Md. and Falls Church, Va.; also from Raleigh, N. C., and Washington County, Pa. Occurs mostly in March and April in the South, May and June in the northern part of its range.

Labostigmina rufipennis James, new species

Female.—Head mostly greenish yellow, the following areas black: a small spot on the vertex, including the ocellar triangle but not reaching the eyes; an oblique stripe on each side at middle of front; an area extending from lower part of front over antennal bases to facial prominence; and the center of the occiput; usually some black or blackish on the oral margin. Pile short, inconspicuous, mostly pale; some very short black pile on upper part of front. Antennal scape and pedicel yellow, flagellum black or blackish; ratio of scape, pedicel and flagellum 2: 1: 4. Proboscis black, rather robust.

Mesonotum mostly black, postalar calli and a lateral stripe running from each to the suture, except for a small triangle at the suture, greenish-yellow; humeri and scutellum, except very narrow base of latter, greenish-yellow; spines of scutellum small, almost evanescent, yellow. Middle of propleura, upper parts of mesopleura, of sternopleura, and of hypopleura, pteropleura except small spot at lower anterior corner, and anterior part of metapleura, greenish-yellow. Pile of pleura pale, sparse; mesonotum with black and pale tomentum, but with hardly any pile. Coxae and femora, except apices of latter, black; apices of femora, tibiae, and tarsi reddish-yellow, apical tarsomeres becoming blackish. Wings reddish-hyaline, veins reddish-yellow; r-m variably present or absent. Halteres reddish-yellow, knobs becoming yellow or greenish-yellow.

Abdominal terga black, marked with greenish-yellow as follows: a triangle at each posterior angle of first and second, that of second attaining base of segment and concave inwardly; third and fourth with a narrow transverse rectangle at each posterior corner; fifth with narrow lateral and broad posterior margins. Tomentum pale toward sides and black on disc; hardly any pile evident. Venter green with pale tomentum.

Length, 8–9 mm.

Male.—Head black, a small yellow spot at apex of oral margin, below facial prominence; pile of head pale except a few black hairs between the eyes, moderately dense but only half as long as first antennal segment. Face across lower angle of eyes 0.45 head width; thorax black except scutellar spines; pile pale, that of mesonotum fairly dense and erect but not much over half length of first antennal segment. Wings not as distinctly reddish as in female. Abdominal markings similar to those of female but more restricted and more yellowish; triangles of second tergum scarcely reaching base of segment; pile erect, black and pale, the

black pile shorter and restricted to the sides; pale pile sparse on disc. Genitalia reddish yellow.

Types.—Holotype female, Travis Co., Texas; James Collection. *Allotype* male, Texarkana, Texas, May 19, 1934 (J. N. Knull); Ohio State University. *Paratypes:* two females, Uvalde, Texas, May 3, 1941 (D. J. and J. N. Knull).

Labostigmina similis (Johnson)

Odontomyia similis Johnson, 1895, Trans. Amer. Ent. Soc. 22: 267; Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 214; James, 1936, Jour. Kansas Entom. Soc. 9: 44 (inclusion in *Odontomyia* by error).
Labostigmina similis (Johnson), James, 1936, Jour. Kansas Entom. Soc. 9: 35; 1936; Trans. Amer. Entom. Soc. 62: 36.

An uncommon high-altitude species of the Rocky Mountains, from Alberta to Utah and Southern Colorado (Gothic); June to August. In Colorado and southern Wyoming it occurs at elevations of 9000 to 10,000 feet.

Labostigmina hieroglyphica (Latreille)

Odontomyia hieroglyphica Latreille, *in* Olivier, 1811, Encycl. Méth., viii, p. 434.
Odontomyia hieroglyphica Olivier, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 267.
Odontomyia fallax Johnson, 1895, Trans. Amer. Entom. Soc. 22: 257 (new synonymy).
Labostigmina fallax (Johnson), James, 1936, Trans. Amer. Entom. Soc. 62: 36.

This seems to be the Eastern counterpart of *johnsoni*, and though a variable species, there seems to be no intergradation. Variation occurs chiefly in the extent of the lateral pale stripe of the mesonotum, which may be complete or may occur only behind the suture. The scutellar spines may be very small; Johnson thought them to be lacking in what he described as *fallax*. Apparently fairly common from Mississippi to Georgia and northward to Maine and Illinois. Crevecoeur's record for Kansas and Melander's record for Texas are probably based on misidentifications.

Labostigmina occipitalis (Johnson)

Odontomyia occipitalis Johnson, 1895, Trans. Amer. Entom. Soc. 22: 268.
Labostigmina occipitalis (Johnson), Enderlein, 1929, Deut. Entom. Zeits. 1930: 70; James, 1936, Trans. Amer. Entom. Soc. 62: 36.

An uncommon, but widespread, eastern species; Pennsylvania and New Jersey westward to Michigan and Tennessee, and southward to Georgia.

Genus **Hoplitimyia** James

1934, Ann. Entom. Soc. Amer., 27: 443; James, 1939, Jour. Kansas Entom. Soc. 12: 37. Type, *Stratiomys constans* Loew.

KEY TO THE NEARCTIC SPECIES OF *Hoplitimyia*

1. Second and third abdominal terga each with a broad, usually interrupted yellow crossband, the pale markings having the appearance of triangles, the band sometimes continuous, though constricted medially, on the third tergum; scutellum yellow; mesonotum on each side in front of suture with a prominent yellow spot or sometimes the entire lateral margin yellow; abdomen of male conspicuously silvery-tomentose above, the tomentum, however, evident only from an anterior view and under illumination . . . . . **constans**

Second and third abdominal terga with at most linear markings in the males and practically wholly black in the females; scutellum in part

black; mesonotum on sides at most slightly yellowish at suture; abdomen not silvery-tomentose in either sex..... 2

2. Second and third abdominal terga practically wholly black in both sexes, but the fourth and fifth terga each with a prominent yellow transverse band; scutellum yellow with a distinct preapical band black, this band in the male sometimes extending over most of the dorsal surface of the scutellum..... **mutabilis**

Second, third and fourth abdominal terga of the male each with a linear transverse apical yellow margin, which is frequently interrupted medially; terga of the female marked as in *mutabilis;* scutellum black with a yellow apex in the male, yellow with a black base in the female..... **fasciata**

Hoplitimyia constans (Loew)

Stratiomyia constans Loew, 1872, Berliner Entom. Zeit., 16: 55 (Centuria X, 8); Johnson, 1895, Trans. Amer. Entom. Soc. 22: 244.
Stratiomys constans Loew, Curran, 1927, Trans. Roy. Soc. Canada (v, 3) 21: 204.
Hoplitimyia constans (Loew), James, 1934, Ann. Entom. Soc. Amer. 27: 444; 1939, Jour. Kansas Entom. Soc. 12: 43.

Common in Texas, Oklahoma, and Kansas, and extending westward through New Mexico to Arizona and eastward into Arkansas. A record for Lawrence, Indiana, June 20, 1943 (F. C. Harmston) is rather surprising and may be in error.

Hoplitimyia mutabilis (Fabricius)

Stratiomys mutabilis Fabricius, 1787, Mantissa Insectorum, 2, p. 331.
Stratiomyia mutabilis Fabricius, Johnson, 1895, Trans. Amer. Entom. Soc. 22: 243.
Hoplitimyia mutabilis (Fabricius), James, 1934, Ann. Entom. Soc. Amer. 27: 444; 1939, Jour. Kansas Entom. Soc. 12: 40.

A Neotropical species which enters the United States in Southern Arizona (Pima County, Tucson) and Southern Texas (Donna, Harlingen, Kingsville).

Hoplitimyia fasciata (Fabricius), new combination

Stratiomys fasciata Fabricius, 1787, Mantissa Insectorum, 2, p. 331.
Stratiomys vespoides James, 1933, Jour. Kansas Entom. Soc. 6: 67 (new synonymy).
Hoplitimyia vespoides (James), 1936, Jour. Kansas Entom. Soc. 9: 35; 1939, Jour. Kansas Entom. Soc. 12: 42.

The record of this species for the Nearctic region is based wholly on the type data of *S. vespoides*, namely, "Colo., July."

In view of the known distribution of this Neotropical species, it is highly doubtful whether the type of *vespoides* came from Colorado, and its positive inclusion in the Nearctic fauna must depend upon its rediscovery there.

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TAXONOMIC NOTES ON AN EXOTIC CENTIPEDE TAKEN IN ILLINOIS

(Chilopoda: Lithobiomorpha: Henicopidae)

STANLEY I. AUERBACH[1]

In the course of analysis of a large collection of centipedes belonging to the Illinois State Natural History Survey a series of lithobiid centipedes was identified as *Lamyctinus coeculus* (Brōl.). This species hitherto has not been reported from the United States proper although it has been taken in Mexico (Silvestri 1909, Chamberlin 1943). The present material was collected in a greenhouse at Urbana, Illinois on April 5, 1933 by Mr. C. C. Compton. Undoubtedly the species was introduced with some exotic plant. This has been reported frequently for centipedes.

The availability of this material afforded an opportunity for a review and evaluation of its systematic status. *Lamyctinus coeculus* was first described by Brölemann in 1889 as *Lithobius coeculus*. In 1892 Berlese redescribed it and assigned it to the genus *Henicops*. In 1908 Attems listed it under *Lamyctes* in a key to the Palaearctic species of that genus. *L. coeculus* was separated from the others in the key by its lack of ocelli. In 1909 Silvestri studied some of the genera of the Henicopidae and concluded that *coeculus* was sufficiently different from other *Lamyctes* to justify it being placed in a separate genus. Accordingly he erected the new genus *Lamyctinus* and designated *coeculus* as the type species.

In 1930 Brölemann in his monograph for the Faune de France series redescribed this species under *Lamyctes*. He argued that the presence or absence of ocelli is a variable character within other genera and therefore is not of generic importance. This may be true but it is equally true that the morphology of one genus may vary independently of another.

Furthermore Brölemann implies that Silvestri's description is not accurate, because as he says, "D'apres le même auteur, il n'existerait pas de pores coxaux aux P. 12, ce n'est pas le cas chez les individus de Lombardie." This is not a fair statement of the situation because the present writer believes that a typographical error, not necessarily the fault of Silvestri, may be involved.

In his original paper Silvestri has a generic description as well as a species description. In his description of the genus Silvestri says, "Articulus basalis pedum *13–15* poris instructus est." This line is *immediately preceded* by the line, "Pedes *13–15* (Fig. I, 10–11) tarso . . . ." (italics mine). *But* in his description of *L. coeculus* as the type species Silvestri writes, "Articulus basalis pedum *12–15* poris 1, 2, 2, 2, (interdum 1, 3, 3, 2)." It is the present writer's belief that

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the numeral 13 was inadvertently repeated in the sentence describing the coxal pores from the sentence describing the tarsi. Although in the detailed species description the correct numeral, 12, is used, one rapidly reading the entire section could easily note the repeated number 13 and overlook 12. If such is the case then Brölemann's implication in unwarranted.

The specimens examined by the author are quite distinct from typical American species of *Lamyctes*, in color and antennal length in relation to body length, in addition to the lack of ocelli. Because of this the present writer feels that the genus *Lamyctinus* should be retained pending proof of ocelli variability within the genus *Lamyctes* and closely related genera.

The specimens from Urbana agree in all major features with the species description of Silvestri which was based on Mexican material. They vary from the description in two minor details. The number of articles of the antennae range from 20–24 (Silvestri limits the number to 24). The lower number is probably due to the immaturity of some of the specimens. The Illinois specimens have more plumose setae on the mesial margin of the telopodites of the first maxillae than do those of Silvestri. These differences are not of specific importance.

With regard to the distribution Silvestri reported the species from Italy, Mexico, Hawaii, and Australia. In 1943 Chamberlin stated that the species is now found throughout the world including Europe. The collected sample that is the basis for this article includes three adults and six immatures. This indicates that the species had become established in the particular greenhouse.

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KÖRPERGRÖSSE UND ORGANZAHL DER ORGANISMEN by F. A. SCHILDER. Hallische Monographien, nr. 18. 58 pages, 40 figs. Max Niemeyer Verlag Brüderstr. 6, Halle (Saale), Germany. Price, DM 6.80.

In this interesting study, the author has selected homologous structures which may vary in number within limits and has made a comparison of the number of such structures with the size of the organism. Fifteen examples have been chosen from animal and plant kingdoms, including the tube feet of starfish, the facets of an insect eye, the scales of lepidopterous wings, the cells of plants, and the sori of ferns. The author concludes that the number of organs is not proportionate to the size of the organism, but rather that the ratio decreases as the size of the organism increases.—M. T. J.

NEW SPECIES OF PEGOMYIA FROM MEXICO

(Diptera: Muscidae)

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Descriptions of five new species of *Pegomyia* Robineau-Desvoidy (1830, p. 598)[1] which were collected by the author during a one day automobile trip from Mexico, D. F. to Cuernavaca, Morelos on August 15, 1943 are presented. It is hoped this will emphasize the rich fauna occurring in this area. Of more significance is the similarity of these species to those found in the continental United States and, as will be seen from the discussions following their descriptions, they are readily placed in those more Northern species-groups keyed and discussed by Huckett (1941, p. 12–21). This confirms the phylogenetic value of the group characters which he has selected.

Holotypes will be deposited in the American Museum of Natural History.

These new species have the following characters in common and are enumerated now to avoid later repetition. Dorsocentral bristles 2: 3; posterior intraalars 2; no setulae on notopleura adjacent to either bristle; sternopleurals 1: 2; scutellum with a well developed pair of basolateral and apical bristles; fore femora with a row of posterodorsal and posteroventral bristles; mid femora with a preapical anterior, posterodorsal and posterior bristle; hind femora with a complete row of anterodorsal bristles; hind tibiae with two posterodorsal bristles, and without a partial or complete row of posterior or posteroventral setulae; sixth wing vein clearly traceable to posterior margin of wing.

Pegomyia tarsadisca new species

Male.—Length 5.0 mm. Head black, grayish pruinescent; anterior portion of frontal vitta with reddish to fulvous reflections. Parafrontals broadly contiguous at middle where the front is not wider than the diameter of the anterior ocellus. With three pairs of parafrontal bristles on the anterior two-fifths. In profile, the parafacials very narrow and the cheeks are about as high as width of third antennal segment. Second antennal segment fulvous brown, the third infuscated, densely grayish pruinescent, and about 2.6 times as long as the second, descending to about the greatest diameter of arista above oral margin. Longest aristal hairs 0.8 as long as greatest aristal diameter. Palpi slender, fuscous; proboscis short, dark, shiny.

Thorax black, silvery gray pruinescent, dorsum of scutellum grayish brown pruinescent. When viewed from above, there appears to be a broad, dark, subshiny black transverse band, with irregular anterior

[1]Refers to references in literature cited at end of this paper.

and posterior margins, which covers most of the area between the posterior presutural dorsocentral and the posterior postsutural dorsocentral bristles and also with a median subtriangular posterior excision extending to the prescutellar acrostical bristles. With three pairs of moderately well developed presutural acrostical setulae; the average distance between them is approximately the same as average distance between the outer acrosticals and the dorsocentrals. Posterior posthumeral bristle not duplicated; prealar 0.6 as long as anterior notopleural bristle and 0.8 to 0.9 as long as the posterior one. Disc of scutellum bare or with at most three or four sublateral clothing setulae in addition to the short pair of preapical bristles and row of closely set marginal clothing setulae; the apical setulae are similar to these and considerably stronger than the ventral hairs. With a short, fine, anterior mesopleural setula below the anterior notopleural bristle and with a fine, upwardly directed bristle below the longer propleural and prostigmatal bristle.

Coxae and femora fuscous, the remainder of legs brownish yellow. Fore tibiae with a well developed posterior bristle slightly beyond middle and a very short anterodorsal setula which is scarcely as long as tibial diameter. The apical dorsal and posteroventral bristles distinct and longer than tibial diameter. Mid femora with four ventral bristles on basal one-third. Mid tibiae with a short anterodorsal at apical one-fourth and two posterodorsal bristles. Hind femora with a row of anteroventrals which become gradually longer towards apex and a row of about six irregular posteroventral bristles on the basal two-thirds. Hind tibiae with one anteroventral and three anterodorsal bristles; only the apical dorsal, anterodorsal and anteroventral bristles distinct and equal to, or longer than, tibial diameter. All tarsi about as long as their respective tibiae; apical tarsal segments not noticeably broader than others.

Wings brownish hyaline, this color somewhat stronger along fore margin and beyond apex of first vein. Diameter of costa basad to subcostal juncture rather narrow, but with numerous very short setulae. Node bare on both surfaces. Cross veins without suffusions, the posterior one with a slight median curvature. Calyptrae subequal, concolorous with wings. Halteres yellow.

Abdomen dorsoventrally compressed, almost parallel sided but evenly rounded apically. Concolorous with thorax but with indications of a faint dorsocentral vitta on third and fourth visible tergites. Basal hypopygial segments subshiny black. Tergites with numerous rows of upright clothing setulae and a row of apical bristles on the first four visible tergites. Fifth sternite with numerous clothing setulae on lateral processes.

Female.—Length 4.75 to 5.25 mm. Similar to the male. The front parallel sided, about as wide as length of third antennal segment and with the usual parafrontal bristle arrangement of this sex. Cruciate interfrontal bristles absent. Posterior ocellar bristles outwardly directed. Frontal vitta very narrowly fulvous orange adjacent to the suture.

The dark transverse thoracic band narrower and extending only to the second postsutural dorsocentral bristle. Average distance

between presutural acrostical bristles slightly greater than the average distance between them and the dorsocentrals and with several short clothing setulae between the acrosticals.

Fore tibiae with the submedian anterodorsal bristle subequal to the posterior one. Mid femora with a median and several basal anterior bristles and with only one or two shorter basal ventrals. Hind femora without as numerous or as long posteroventral bristles. Fore tarsi slender, as long as fore tibiae; the other tarsi shorter than their corresponding tibiae and the fourth and fifth tarsal segments considerably broadened, wider than long and in this respect similar to *winthemi* Meigen and *mallochi* Huckett.

Wings somewhat shorter, broader and more evenly rounded apically; posterior cross veins straight.

Abdomen more shiny, lanceolate and with decumbent clothing setulae. Basal sternite setulae much shorter and less numerous.

Type material:—Holotype, male, Cuernavaca, Mexico, 7,000 ft., Aug. 15, 1943; *allotype*, female and *paratypes*, 3 females, same data as type.

These species belong to Huckett's (1941, p. 20) *geniculata* subgroup of the *flavipes*-group and appear to be most closely allied to *winthemi* Meigen and *mallochi* Huckett on the basis of the broad apical female mid and hind tarsi, although the male traces to *longicornis* Huckett in his key to North American *Pegomyia* (1941, p. 26). Both sexes of *tarsadisca* may be separated from *winthemi* and *mallochi* by having all femora infuscated and a ventrally darkened scutellum. The males differ from the description of *longicornis* Huckett (1939, p. 14) in not having the posthumeral bristles duplicated.

Pegomyia spinisoides, new species

Male.—Length 5.75 to 6.75 mm. Head blackish, cinereous pruinescent, the cheeks with reddish brown reflections and the anterior portion of frontal vitta reddish black. Frontal vitta complete along entire length, at narrowest part, 1.5 times as wide as diameter of anterior ocellus and two to three times as wide as width of a parafrontal at same level. With three to four pairs of convergent parafrontal bristles on anterior half. In profile, juncture of parafacials and parafrontals almost as long as the length of the rather short third antennal segment, the parafacials narrowed to one-half this width below. Caudoventral area of head very prominent. The cheeks at least as high as length of third antennal segment and 0.3 of eye height. With a row of four to six long, strong, upwardly curved bristles along ventral margin. Antennae infuscated, the apex of second segment narrowly fulvous. Third segment 1.3 to 1.5 times as long as second. Longest aristal hairs not longer than greatest diameter of arista. Palpi yellow. Proboscis short, dark, sparsely pruinescent.

Thorax brownish black, yellowish gray pruinescent. Viewed from above and behind, without obvious vittae or stripes, but the dorsocentral bristles appear to be surrounded by somewhat more brownish pruinescence. With three pairs of presutural acrostical setulae which are short, closely placed and widely separated from the dorsocentrals.

Prealar absent; posterior posthumeral bristle not duplicated. Scutellum with only a few sublateral clothing setulae on disc and those on the lateral declivitous portion sparse and irregular, the apical setulae coarser than the ventral hairs. Anterior mesopleural setula short but distinct.

Legs infuscated, trochanters, apices of femora and tibiae fulvous yellow. Fore femora with one or two distinct posterior bristles at base in addition to the usual rows of bristles. Fore tibiae with a posterior and anterodorsal bristle beyond middle and with a strong apical dorsal, posterodorsal and posteroventral bristle. Mid femora with two ventral bristles at base and a row of about five very short anterior setulae on the basal third. Mid tibiae with one anterodorsal, and two posterior to posterodorsal bristles and sometimes with a weak posterior to posteroventral series. Hind femora with two basal and three to four anteroventral bristles on apical third and a fine basal ventral. Hind tibiae with two anterodorsal and a single anteroventral bristle; the apical dorsal, anterodorsal and anteroventral bristles well developed. Tarsi normal, subequal in length to their respective tibiae.

Wings hyaline with a yellowish tinge. Costa with three or more bristles well basad to, and also beyond, costal thorn, most of these are as long as the humeral cross vein and distinctly longer than the anterior cross vein; with numerous long costal setulae between them, many of which are almost two times as long as the diameter of costa where situated. Node with several setulae on ventral surface. Posterior cross veins slightly curved in center. Without distinct suffusions around either cross vein. Halteres yellow. Calyptrae white, the upper one considerably larger than the lower one.

Abdomen dark brown to black, cinereous pruinescent, a variable lateral portion of first and second visible tergites yellowish; and with only a very faint or shadowy indication of a dorsocentral vitta. Prebasal hypopygial sclerite prominent, pruinescent, without bristles. The anal tergite concolorous and with six to eight discal bristles in a semicircular row. First to fourth visible tergites with a row of long apical bristles and without discals, the clothing setulae mostly short and decumbent. Fifth sternite with moderately broad lateral processes having long, prominent clothing setulae.

Type material:—Holotype, male, Cuernavaca, Mexico, 9,800 ft., Aug. 15, 1943; *paratypes*, 3 males, same data as type, 1 male same but at 7,000 ft., and 3 males, Mexico City, 9,000 ft., Aug. 15, 1943.

Pegomyia spinisoides belongs to Huckett's *affinis*-group and in his key (1941, p. 25) traces to *spinigerella* Malloch. However, in most structural characters, *e.g.* costal armature, bristling of femora and scutellum it appears more closely allied to *spinosissima* Stein, but may be separated from that species by the unclouded cross veins, darker color of the antennae, head and femora and with more numerous long, costal bristles basad to the costal thorn.

Pegomyia nigracaerulea, new species

Male.—Length 5.0 to 5.5 mm. Head black, silvery gray pruinescent. Parafrontals narrowly contiguous beyond center of front; at narrowest part, the front is 1.25 times as wide as diameter of anterior

ocellus. With convergent parafrontal bristles on the anterior one-half. Juncture of parafacials and parafrontals in profile not more than 0.75 as long as width of third antennal segment, and the parafacials considerably narrower below. Cheeks slightly higher than width of third antennal segment. Palpi and antennae black, third antennal segment 2.25 times as long as second. Arista plumose, the longest hairs as long as greatest width of third antennal segment.

Thorax bluish black, with sparse grayish pruinescence and without distinct vittae. Three pairs of slender prescutellar acrostical setulae. Prealar longer than either notopleural bristle. Lateral marginal scutellar setulae in an irregular row and these are longer and coarser than the apical hairs which are similar to those on the ventral surface. Scutellar disc mostly bare.

Legs black, with somewhat brownish reflections. Fore tibiae with a strong submedian posterior and a much shorter anterodorsal bristle; only the dorsal and posteroventral apical bristles distinct. Mid femora with three to four ventral bristles on the basal half. Mid tibiae with one anterodorsal, one posterodorsal bristle beyond middle and with two median posterior ones. Hind femora with a row of anteroventral and one or two submedian posterodorsals. Hind tibiae with two anterodorsal and one anteroventral bristle, the apical dorsal, anterodorsal and anteroventral bristle well developed and longer than tibial diameter.

Wings hyaline, with a faint brownish yellow tinge. Costal thorns and setulae short. Posterior cross vein almost perpendicular. Node bare. Neither cross vein with dark suffusions. Calyptrae white, subequal. Halteres fuscous yellow.

Abdomen bluish black, sparsely gray pruinescent and without dorsal marks. Prebasal hypopygial sclerite with several long bristles and a few short setulae. First to fourth visible tergites with a row of long marginal bristles. Fifth sternite with distinct lateral processes and a basal mat of very numerous, fine, short setulae.

Type Material.—Holotype, male, Amecameca, Mexico, 8,000 ft., Aug. 15, 1943; *paratype*, male, same data as type.

This species, despite the presence of sparse pruinescence on the hypopygial segments, appears to belong to Huckett's *virginea*-group (1941, p. 14). The dark legs will easily separate it from *juvenilis* Stein, while the absence of a distinct thoracic and abdominal pattern will distinguish it from *palposa* Stein.

Pegomyia verticala, new species

Male.—Length 5.25 mm. Head dark, grayish pruinescent, the broad frontal vitta largely reddish and the cheeks and parafacials with similar reddish to fulvous reflections. Frontal vitta broad along its entire length, at its narrowest part as wide as distance across posterior ocelli inclusive, and at the same level, each parafrontal is about half its width. With convergent parafrontal bristles which are continued to slightly in front of the anterior ocellus. Inner verticals and anterior ocellar bristles well developed, about as long as the anterior presutural dorsocentral bristle and the outer verticals about half as long. Juncture of parafacials and parafrontals in profile not quite as long as width

of third antennal segment, the parafacials narrowed to 0.5 to 0.66 this distance below. Cheeks somewhat higher than width of third antennal segment, ventral margin almost straight and with two or three strong, upwardly directed bristles near middle. Palpi black. Antennae black, the second segment with a very small, lighter colored area at apex on dorsal surface. Third segment about twice as long as the second. Longest aristal hairs shorter than greatest diameter of arista.

Thorax black, yellowish pruinescent. Marked and bristled as in *duplicata* Malloch (1918, p. 308), but the posterior posthumeral bristle is not duplicated.

Coxae, tarsi and fore femora infuscated, remainder of legs fulvous except for a variable dark median dorsal suffusion on mid and hind femora. Legs bristled as in *duplicata*, but mid tibiae with a submedian anteroventral bristle.

Wings hyaline with a faint yellowish tinge. Costal thorn long and prominent, the setulae basad and slightly beyond the juncture of subcosta prominent, almost two times as long as diameter of costa where situated. Posterior cross vein very slightly sigmoid; neither cross vein with distinct suffusions. Calyptrae white; halteres yellow.

Abdomen as in *duplicata*.

Female.—Length 5.25 to 6.25 mm. Similar to the male except for the usual secondary sexual characters and very similar to the female of *duplicata*, but differs from that species in having somewhat longer costal setulae, the posterior posthumeral bristle not even weakly duplicated and in having no suffusions around the cross veins.

Type Material.—*Holotype*, male, Mexico City, Mexico, 9,000 ft., Aug. 15, 1943; *allotype*, female, same data as type; *paratypes*, 3 females, same data as type, and 1 male, Amecameca, Mexico, 8,000 ft., Aug. 15, 1943.

See discussion following description of *Pegomyia duplicoides*.

Pegomyia duplicoides, new species

Male.—Length 6.5 to 6.75 mm. Head black, grayish pruinescent. Front at narrowest part not as wide as greatest diameter of arista or the anterior ocellus. Antennae black, the second segment with only a very faint yellowish tinge at extreme dorsal apex. Palpi entirely black.

Thorax colored and marked as in *duplicata*. Posterior posthumeral bristle distinctly duplicated.

All femora black, only the extreme apex concolorous with the tibiae and this light apical area does not extend basally beyond the most apical bristle. Mid femora without well developed anterior bristles on the basal half. Mid tibiae usually with a short median anteroventral bristle.

Cross veins with no more suffusions than along the longitudinal veins.

Female.—Length 7.0 mm. Similar to the female of *duplicata* but with infuscated femora and the cross veins without distinct suffusions.

Type Material.—*Holotype*, male, Cuernavaca, Mexico, 9,800 ft., Aug. 15, 1943; *allotype*, female, same data as type; *paratypes*, 3 males, same data as type, and 1 male, Mexico City, 9,000 ft., Aug. 15, 1943.

The preceding two species are very similar to *duplicata* Malloch (1918, p. 308) and some workers might regard them as geographical subspecies of that rather variable species. For a discussion of this variability see Malloch's original description and Huckett (1941, p. 94). The main distinguishing characters of *verticala* and *duplicoides* are noted in the preceding descriptions and appear constant. Until more material from intermediate localities is available they are considered to be specifically distinct from *duplicata*. The following couplets will distinguish the three species.

1. All femora infuscated except at extreme apex..... **duplicoides**
   Mid and hind femora largely fulvous..... 2
2. **Male:** front at narrowest part not wider than distance across posterior ocelli inclusive; outer vertical bristle shorter than anterior ocellar bristle. **Female:** anterior and posterior cross veins with distinct dark suffusions... ..... **duplicata**
   Male: front at narrowest part almost two times as wide as distance across posterior ocelli inclusive; outer vertical bristle as long as the anterior ocellars. **Females:** anterior and posterior cross veins without dark suffusions..... **verticala**

Pegomyia nigrifemur Stein

1918, Ann. Mus. Nat. Hung., 16: 240.

This species was described from several pairs in Bezzi's collection taken in "Mts. near Cuernavaca, Mexico." The description, while suggestive of *duplicoides* is too generalized to make identification certain, since the characters now in use to separate species in this complex, *duplicata* Malloch, *longimana* Pokorny, *setiformis* Huckett and *fuscicauda* Huckett, were not used by Stein. An examination of his material will therefore be necessary before *nigrifemur* can be recognized with any certainty.

In describing the leg bristles, Stein wrote that they were somewhat like *cinctinervis* ("etwa die bei *cinctinervis*") after which he described the hind femoral bristles of *nigrifemur*. In the description of *cinctinervis* Stein (1918, 239), a species not known to me, the mid tibiae are described as having a single anterodorsal, posterodorsal and posterior bristle distad to the middle (? "hinten"). In the three species keyed above there are two distinct posterior bristles on the median half, although the proximal posterior one in the two Mexican species are shorter than the distal one, and in some paratypes this bristle is either short or broken off, though the pore is clearly visible. It is conceivable that this was also the case with Stein's specimens of *nigrifemur* and prompted the use of "etwa," although it is possible, and perhaps more probable, that the use of this qualifying word was due to the difference in the bristling of the hind femora, mention of which was not made in describing *cinctinervis*. In connection with the mid tibial armature, it may be significant to note that in describing *fuscinervis* St., a synonym of *duplicata*, Stein (1920, p. 70) mentions the presence of two posterior bristles. The females of *nigrifemur* are said to be similar to the males, but with dark brownish yellow ("schmutzig braungelb") femora. This could indicate either a sexual variation in femoral color or that his series contained specimens of *verticala*.

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INSECT CONTROL BY CHEMICALS, by A. W. A. Brown. 817 pages. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1951. Price, $12.50.

This book is the most comprehensive of the several recently published in this field. Its eleven chapters bring together for the first time much of the literature on the current trends in economic entomology. The preparation of a book with such intensive coverage is a tremendous undertaking for one author and Professor Brown has achieved a very readable book based on over 2,200 references. However, its very wide scope has undoubtedly contributed to the number of misstatements and editorial errors that were observed.

An errata sheet is urgently needed to correct such obvious errors as the following:

Page 4, line 10. "alkali dehydrochlorinates it (DDT) to the dichloroethylene or *ethane analogue*."

Page 6, line 11. "No colour (Schechter-Haller procedure) is given with any other chlorinated hydrocarbon."

Page 30, line 24. "It" in the reference cited refers to scabrin, not affinin.

Page 268, Fig. 2. "Impact" should be "intact."

Page 290, line 13. "Fig. 13" should be "Fig. 16."

Page 299, line 3. No mention of propyl isome nor fagaramide is made in the references cited, 82 or 83.

Page 299, line 30. The punctuation is such as to indicate that an amide is a methylenedioxyphenyl compound.

Page 319, line 3. The statement that no insect has been found resistant to lindane is contrary to many published reports.

Page 469, line 4. This sentence states that toxic residues on plant products is negligible in the case of parathion but the next sentence states that it is appreciable.

Page 740, Sect. D. No mention of resistant flies in Cairo is made in reference 7.

Page 744, line 17. The reference cited (5) did not comment on the existence of insecticide resistant strains of Anopheles mosquitoes.

The references cited will be of considerable value to those interested in source material if it is borne in mind that, although not indicated by the author, the titles given are not those of the original publication.

Some of the authors cited drew conclusions from meager or preliminary data and it is regrettable that Prof. Brown did not more carefully evaluate such data before making statements of fact based on the conclusions.

That "The central nervous system of the insect is cholinergic" (page 253) is questionable. The definition of synergism (page 299) adds another very controversial one to the several currently in use.

This book will undoubtedly find wide usage and it will be of particular value to the advanced research worker with sufficient background to evaluate the information furnished.—Frank H. Babers.

THE GENUS ALLUAUDOMYIA KIEFFER IN NORTH AMERICA

(Diptera, Heleidae)

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I have had the pleasure of studying a considerable number of specimens of the strikingly marked little biting midges of the genus *Alluaudomyia*. Many of these specimens were sorted from light-trap collections from Florida, which were kindly sent to me through the courtesy of Mrs. Elisabeth Beck and Mr. J. A. Mulreman of the Florida State Department of Health. Mr. Richard H. Foote, of the United States Public Health Service, has also very generously donated his valuable collection of these midges together with his manuscript notes and drawings. Through the courtesy of Dr. O. A. Johannsen and Dr. Henry Dietrich, of Cornell University, I was permitted to study their collection of *Alluaudomyia*, including the types of *A. needhami* Thomsen.

Seven species of *Alluaudomyia* are now known to occur in North America, two of which have previously been named, one is being described in another paper, and four are named below. The commonest American species, ***bella*** (Coquillett), has for many years been considered the same as the rare European ***splendida*** (Winnertz), but our species differs in several important respects from the European descriptions.

The types of the new species are in the U. S. National Museum. The terminology of wing venation follows that of Tillyard as outlined by Friend (1942). The drawings do not follow a consistent scale. Illustrations of the male genitalia were made with the aid of an ocular grid and squared paper, and those of the wings with a microprojector.

Genus **Alluaudomyia** Kieffer

Alluaudomyia Kieffer, 1913, Voyage Ch. Alluaud et R. Jeannel en Afrique Orientale, Dipt., 1: 12; de Meillon, 1939, Jour. Ent. Soc. South Africa, 2: 7; Tokunga, 1940, Tenthredo, 3: 153; Okada, 1942, Trans. N. H. Soc. Formosa, 32: 315; Johannsen, 1943, Ann. Ent. Soc. Amer., 36: 780. (Genotype: *Alluaudomyia imparanguis* Kieffer, monobasic.)

Neoceratopogon Malloch, 1915, Bull. Ill. St. Lab. Nat. Hist., 11: 310. (Genotype: *Ceratopogon bellus* Coquillett.)

Prionognathus Carter, Ingram, & Macfie, 1921, Ann. Trop. Med. & Parasit., 16: 309. (Genotype: *Prionognathus marmoratus* C. I., & M., orig. desig.)

Thysanognathus Ingram & Macfie, 1922, Ann. Trop. Med. & Parasit., 16: 244 (n. nom. for *Prionognathus* C., I. & M., not LaFerté-Sénectère, 1851).

Isoecacta Garrett, 1925, Seventy New Diptera, p. 9. (Genotype: *Isoecacta poeyi* Garrett, monobasic.)

Diagnosis. Eyes bare or hairy, narrowly separated above. Antennae 15-segmented, last five segments elongated in female, last three in male. Wing with rather abundant macrotrichiae distally,

microtrichiae absent; wing usually adorned with small black spots; radial cells subequal, the first usually obliterated, the second broad, veins greatly thickened at apex, ending at about half of wing length; media forked and petiolate. Legs slender, without spines; middle basitarsus elongated, hind basitarsus bearded ventrally; fourth tarsal segment cordate; claws of female usually unequal, the anterior claw about twice as long as posterior; male claws short and equal; empodium vestigial.

Although Kieffer originally characterized *Alluaudomyia* as possessing microtrichiae on the wings, and he (1925) and Goetghebuer (1933) later repeated this character for *splendida* (Winnertz), the very fine, blunt, microscopic punctations of the membrane appear to have been misinterpreted as microtrichiae. The genus *Thysanognathus*, which differs thus from *Alluaudomyia* only in not possessing these so-called microtrichiae, must remain a synonym as considered by de Meillon (1939), Macfie (1940) and Johannsen (1943), and is hardly worth the subgeneric rank accorded it by Okada (1942).

KEYS TO THE NEARCTIC SPECIES OF ALLUAUDOMYIA

Females

1. Smaller species, less than 1.2 mm.; wing with two black spots, at front of first radial cell and at tip of second radial cell; macrotrichiae very sparse; four marginal scutellar bristles 2
   Larger species, rarely less than 1.5 mm.; wing with 8–12 small black spots, those on posterior veins at least faintly indicated; macrotrichiae abundant; scutellum with two submedian marginal bristles, and second pair if present, on anterior face 3
2. Mesonotum dark brown with regular pattern of large rounded silvery pruinose spots; abdomen with narrow apical light bands ..... 6. **parva**
   Mesonotum grayish pruinose, with minute brown punctures, without prominent pattern; abdomen with lateral white spots ..... 7. **downesi**
3. Wing with marginal black spots located on the membrane midway between the veins ..... 4. **stictipennis**
   Wing with marginal black spots located on the veins 4
4. Twelve black wing spots, the marginal spots included in prominent long white spots; legs mottled; abdomen usually black above 5
   Eight to ten black wing spots not enclosed in white spots; legs banded but not mottled; abdomen yellow above 6
5. Posterior wing veins not darkened; two scutellar bristles; abdominal tergites with narrow apical white bands ..... 2. **footei**
   Posterior wing veins darkened; four scutellar bristles; abdominal tergites without apical white bands ..... 3. **paraspina**
6. Wing with eight, well defined, rounded, black spots; hind tibia with three light rings ..... 1. **bella**
   Wing with ten, more or less prominent, black spots, those on posterior part of wing reduced to lines along veins, hind tibia with two light rings ..... 5. **needhami**

Male Genitalia[1]

1. Stem of parameres gradually expanded to knob-like apices, without distal spines or recurved narrowed part; apicolateral processes well developed 2
   Stem of parameres with apex not knobbed, but bearing spines or greatly attenuated recurved blade 3
2. A long, stout spine between inner margin of basistyle and base of parameres; aedeagus with apex bilobed; dististyle abruptly bent beyond middle ..... 3. **paraspina**

[1]Males of *downesi* and *stictipennis* unknown.

Base of basistyle and parameres simple, without long spine; aedeagus with apex trilobed; dististyle arcuate ..... 1. **bella**

3. Genitalia much longer than broad; dististyle less than half as long as basistyle; parameres long and slender with slender hook-shaped base and single, whip-like, recurved, very slender, distal filament ..... 5. **needhami**

Genitalia broader than long; dististyle nearly as long as basistyle; parameres long or short, basal sclerite stout and detached 4

4. Parameres with stem stout and columnar, bearing two short and one long stout apical spines; dististyle arcuate ..... 2. **footei**

Parameres with stem expanded and flattened, apex greatly narrowed ribbon-like and recurved ventrad ..... 6. **parva**

1. **Alluaudomyia bella** (Coquillett)

(Figs. 3, 9)

Ceratopogon bellus Coquillett, 1902, Proc. U. S. Nat. Mus., 25: 67 (Washington, D. C., type ♂ in USNM).

Culicoides bellus Kieffer, 1906, Gen. Insectorum, fasc. 42: 54.

Neoceratopogon bellus Malloch, 1915, Bull. Ill. St. Lab. Nat. Hist., 11: 310 (♂, ♀, Illinois); Johannsen, 1934, Jour. N. Y. Ent. Soc., 42: 54.

Isoecacta poeyi Garrett, 1925, Seventy New Diptera, p. 9 (♀, British Columbia, type in Garrett collection).

Alluaudomyia splendida Johnson, not Winnertz (misident.), 1925, Occas. Papers Boston Soc. Nat. Hist., 7: 46; Thomson, 1935, Jour. N. Y. Ent. Soc., 43: 288; (♂, ♀, New York); 1937, Cornell Univ. Agr. Exp. Sta. Mem. 210: 73 (larva, pupa); Johannsen, 1943, Ann. Ent. Soc. Amer., 36: 780 (Eastern U. S.).

A yellowish species with banded legs, mesonotum yellowish, usually with small brown dots, wings white with eight small widely separated spots on the veins, abdomen usually dark below, yellowish above.

Female.—Length 1.5 mm., wing 1.3 mm. by 0.5 mm.

Head with vertex grayish pruinose; eyes bare, narrowly separated above. Antennal flagellar segments in proportion of 10 : 10 : 8 : 8 : 8 : 8 : 8 : 10 : 10 : 12 : 12 : 10 : 16, each with slightly enlarged base bearing whorl of long hairs and slender apical portion. Palpal segments in proportion of 6 : 5 : 8 : 7 : 12, segments of subequal breadth.

Mesonotum yellowish gray pruinose, typically with long yellow and brownish hairs arising from small brown dots, but sometimes with punctures much reduced. Scutellum yellowish gray pruinose, dark brown in middle; with four bristles, a submedian marginal pair and a pair more widely spaced on anterior side. Postscutellum pruinose brown; pleura pruinose brown, with two broad blackish horizontal bands, one at half of height, other across coxae. Legs yellow, conspicuously annulated with brown bands; fore femora and tibiae and hind femora with broad dark bands in middle; narrow subapical dark rings at end of all femora; narrow subbasal and apical dark rings on all tibiae; mid and hind tibiae in addition with two more narrow dark rings; fore and hind basitarsi dark, mid basitarsus narrowly dark at base and apex. Proportions of segments of hind leg as in Table I; claws long and unequal on all legs.

Wings (figure 3) with eight small black spots as follows: at r-m crossvein (sometimes double), over second radial cell, near ends of veins M_1, M_2, M_{3-4} and Cu_1, near base of M_2 and on anal vein. Long white macrotrichiae distad of level of medial and medio-cubital forks, and in posterior half of anal cell. Halteres white, knob with dark spot.

Abdomen yellowish above, mottled brownish to black on venter,

occasionally all of dorsum except last two segments dark. Spermatheca one, large, subspherical, the duct not sclerotized.

Male.—Similar to the female with the usual sexual differences. Genitalia (figure 9). Ninth sternite about twice as broad as long, with a rounded posterior excavation halfway to base, the membrane evenly spiculate; ninth tergite with distal half subparallel, the apicolateral processes almost as long as the distance between their bases and decidedly divergent, membrane on ventral face of tergite with a mesal spiculate area. Basistyles subparallel, about three times as long as broad, with prominent ventral roots; dististyles slender and incurved, the proximal half more densely pilose. Aedeagus with heavily sclerotized, rounded basal arch, the two lateral valves narrowly joined on ventral side across the apex of this arch, the two lateral valves slender distad, with a prominent, lateral, subapical spur and with a dorsally closed, distally rounded, hyaline channel. Parameres with lateral, basal apodemes originating within base of basistyle, abruptly bent at an 80° angle at proximal third, stems gradually broadening caudad with irregular bulbous apices flanking and well exceeding tip of aedeagus.

Specimens examined:—FLORIDA: Coogler Island, Hernando Co., Jan. 12, 1950, Smith, 1 ♂. Crystal River, Citrus Co., July, 1950, Hudson, 8 ♀♀. Everglades City, Collier Co., Feb. 7, 1950, Peterson, 1 ♀. Fort Myers, Lee Co., Feb. 2, 1949, Brechtel, 4 ♀♀. Innerarity Point, Escambia Co., April, 1949, Rathert, 10 ♂♂, 23 ♀♀. Miami, Dade Co., Oct. 17, 1943, W. W. Wirth, 1 ♀. Panama City Beach, Bay Co., May 6, 1949, McElvey, 1 ♀. Santa Rosa, Walton Co., April 11, 1950, Peterson, 1 ♀. Welaka, Putnam Co., Jan.-June, 1946, R. E. Bellamy, 5 ♂♂, 32 ♀♀.

GEORGIA: Fayette, April 12, 1949, R. H. Foote, 1 ♀. Jonesboro, April 18, 1949, R. H. Foote (reared), 3 ♂♂, 1 pupal skin. Macon, June 1, 1945, H. R. Dodge, 3 ♀♀. Newton, Emory Univ. Field Sta., Mar. 30, 1949, R. H. Foote (reared), 3 ♀♀, 3 pupal skins. Savannah, Oct. 20, 1933, 10 ♂♀. Thomasville, May 15, 1948, E. Palmer, 3 ♀♀.

LOUISIANA: Baton Rouge, April, 1947, W. W. Wirth, 4 ♂♂, 14 ♀♀. Schriener, June 17, 1917 (Cornell), 1 ♀.

OKLAHOMA: Westville, June 15, 1939, Kaiser-Nailon, 1 ♂.

TEXAS: Richmond, Brazos River, June 22, 1917 (Cornell), 1 ♂, 1 ♀.

PENNSYLVANIA: Coatsville, May 23, 1949, H. Horne, 1 ♂.

NEW YORK: Ithaca, May 30-June 2, 1934, O. A. Johannsen (Cornell), 1 ♂, 3 ♀♀. Ithaca, July 28, 1934, O. C. Thomsen (Cornell), 1 ♂.

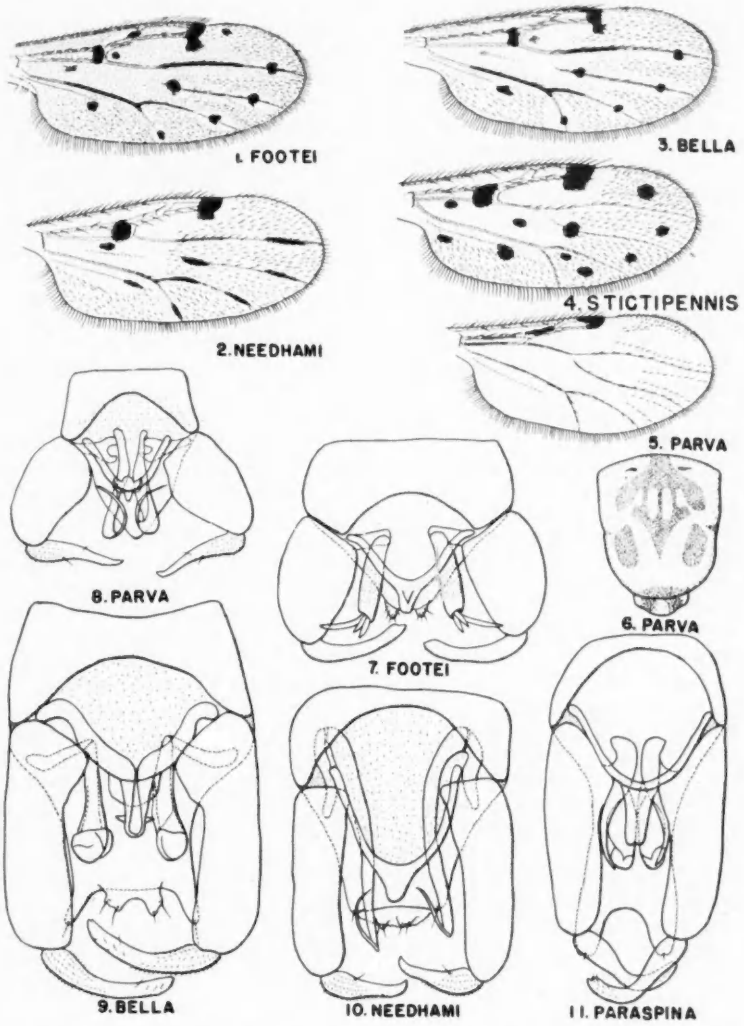
MICHIGAN: E. S. George Reserve, Livingston Co., July 9, 1949, G. Steyskal, 1 ♀.

SASKATCHEWAN: Waskesieu Lake, Prince Albert Nat. Park, June 27, 1950, J. A. Downes, 1 ♂.

UTAH: Laurel Lake, July 8, 1949, H. D. Pratt, 1 ♀.

CALIFORNIA: Snelling, Merced Co., Sept., 1947, Ed Smith, 4 ♂♂, 2 ♀♀.

The European species, *splendida* (Winnertz), is very similar and was thought by Thomsen (1935) and Johannsen (1943) to be the same as the American *bella*. No description is available of the genitalia of



Alluaudomyia species. FIGS. 1, 7, *footei;* 2, 10, *needhami;* 3, 9, *bella;* 4, *stictipennis;* 5, 6, 8, *parva;* 11, *paraspina.* FIGS. 1–5, wings; 6, mesonotal pattern; 7–11, male genitalia, ventral view.

splendida, but even without that evidence I cannot accept this synonymy because of the differences indicated by the descriptions of Kieffer (1925) and Goetghebuer (1933). According to these authors, *splendida* has a brownish median mesonotal stripe; the legs whitish with bands only on the fore and middle tibiae and the fore basitarsus, the hind basitarsus entirely black; and the abdomen black, with very narrow, apical, segmental, white bands.

The four pupal skins from Georgia agree with Thomsen's (1937) figures and descriptions of *splendida*, except in the number of spiracles on the respiratory organ, which vary from 12–20 pairs, in contrast to Thomsen's count of 20–25 pairs.

2. **Alluaudomyia footei** Wirth, new species

(Figs. 1, 7)

A large, yellowish brown, punctate species with mottled and banded legs; wings with twelve black spots, mostly included in prominent white spots; abdomen usually black above, male parameres with heavy spines at apex.

Female.—Length 1.5 mm., wing 1.2 mm. by 0.5 mm.

Head brown, occiput pruinose gray, basal flagellar segments with bases pale, segments 3–10 short tapering, 11–15 long tapering, last segment with short terminal style. Palpi slender, third segment not swollen.

Mesonotum pruinose, silvery gray, with many, rather large, irregular, dark brown dots surrounding bases of the strong mesonotal hairs. Scutellum yellowish gray with narrow, median, brown area; two long, brown, submedian bristles. Pleura pruinose gray, dark brown above coxae. Coxae and trochanters brown, femora yellowish gray with narrow brown annulations and mottling; a sub-basal and subapical pale ring on all femora and tibiae, mid femur and tibia also more or less pale with brown mottling in middle, hind tibia also with a narrow median pale ring; tarsi pale, apices of segments narrowly dark, hind basitarsus entirely dark. Proportions of segments of hind legs as in Table I; claws very long, simple and unequal on all legs, longer claw as long as fifth segment, shorter about two-thirds as long.

Wing (figure 1) dark grayish hyaline, with prominent, small, black spots located in centers of elongated white spots. Eight prominent spots thus at base of r-m crossvein, at apex of second radial cell, near apices of veins M_1, M_2, M_{3+4} and Cu_1, near base of Cu_2 and on anal vein near front of anal cell; four small black spots without white borders on anterior wing margin a fourth way from apex of second radial cell to wing tip, at base of first radial cell, just distad of r-m crossvein and near base of cell M_2. Macrotrichiae very long and dense, covering distal half of wing and all of anal cell. Halteres white, more or less brown on dorsal side and on end of knob.

Abdomen black, apices of tergites narrowly white bordered, especially on sides and on apical segments.

Male.—Similar to female with usual sexual differences. Genitalia (figure 7). Ninth tergite over twice as broad as long, with rounded caudal excavation about halfway to base; ninth tergite conical with

small setose submedian lobes, apicolateral processes absent. Basistyles broad and simple; dististyles strong, subequal diameter to tip, strongly curved, apex with small tooth. Aedeagus with broad rounded anterior arch, distal median point well developed, flattened and recurved ventrad, apex rounded and simple, but with a triangular ventral sclerotization at base. Parameres with short lateral apodemes at base, the submedian stems very stout, straight and strongly sclerotized, slightly spiculate, bearing two short and one long, stout black spines at apex, these bent latero-ventrad, the longest over half as long as stem of paramere.

Holotype ♀, *allotype*, Everglades City, Collier County, Florida, February 7, 1950, Davidson (light trap) (Type No. 60950, USNM). *Paratypes:* 1 ♀. Santa Rosa, Walton Co., Florida, April 11, 1950, Peterson; 1 ♀, Santa Rosa Island, Escambia Co., Florida, May 17, 1949, Butler; 1 ♂, 5 ♀♀, Thomasville, Georgia, May, 1949, G. Palmer.

Closely resembling ***paraspina*** n. sp., and in this respect differing from all other Nearctic species, in having twelve black wing spots, most of which are included in prominent, white-pigmented spots. The allied species ***paraspina*** differs markedly in the male genitalia, with prominent apicolateral processes and a heavy spine at bases of basistyles rather than at the apices of the parameres. I am very happy to name this species for Mr. Richard H. Foote, who has so generously furnished much of the material for this study. The only other known species in which the dark wing spots are included in white-pigmented spots is *wansoni* de Meillon from the Belgian Congo, but in that species the spots are located in the cells between the veins.

3. **Alluaudomyia paraspina** Wirth, new species

(Fig. 11)

Female.—Length 1.8 mm., wing 1.4 mm. by 0.6 mm.

Very similar to *footei* n. sp., but the occiput white; the scutellum with four bristles, two more being more widely spaced on the anterior side; legs with the sub-basal and subapical bands on femora and tibiae less prominent, with a deeper brown mottling giving a more uniform appearance of fine annulations; wing with posterior veins darkened; abdomen black with very faint pearly pruinose small mottlings, last two segments entirely white.

Male genitalia (figure 11).—Ninth sternite deeply excavated, forming a narrow, anterior, band-like sclerite; ninth tergite greatly narrowed and strongly sclerotized, with a pair of long, thumb-like, apicolateral processes. Basistyles very long and slender, over four times as long as broad, sides sub-parallel on distal three-fourths, base of each on inner side with long sclerotized spine also connected to base of paramere; dististyles about half as long as basistyles, abruptly recurved at distal two-thirds, finely spiculate distad, apex with distinct notch forming two short teeth. Aedeagus with rounded slender anterior arch, the distal median lobe two-thirds as long as arch, slightly tapered, with apex distinctly bilobed. Parameres with strong basal apodemes, the stems stout and gradually expanded toward apex much as in ***bella***, apex knobbed with rounded irregular lobes; between base of parameres

and base of basistyle on each side with a long saber-shaped, strongly sclerotized spine with apex reaching knob of paramere.

Holotype ♀, Macon, Georgia, August 29, 1945, H. R. Dodge (Type No. 60951, USNM). *Allotype*, Falls Church, Virginia, July 29, 1950, W. W. Wirth. *Paratypes:* 1 ♂, Macon, Georgia, June 1, 1949, H. R. Dodge; 1 ♂, Dover, New Jersey, May 21, 1949, M. Horne; 1 ♂, 1 ♀, Ringwood, Dryden, New York, May 26, 1933, O. A. Johannsen (Cornell); 1 ♂, 1 ♀, 2 larvae, 1 pupa, Ithaca, New York, May 31, 1933, O. A. Johannsen (Cornell).

Closely allied to *footei* n. sp., from which it may readily be separated by the female characters given above. The male genitalia, with the long spine between the parameres and the inner margin of each basistyle, is very distinctive, resembling the type of arrangement found in the West African species ***marmoratus*** Carter, Ingram and Macfie.

The pupa of ***paraspina*** differs from that of ***bella*** and ***needhami*** in having only thirteen pairs of spiracles on the broad, flattened, distal third of the respiratory organ.

4. **Alluaudomyia stictipennis** Wirth

(Fig. 4)

Alluaudomyia stictipennis Wirth, 1952, Univ. Calif. Pub. Ent., 9: 197 (Orosi, Tulare Co., Calif., type ♀ in USNM).

This species, known from only a single female from California, is very distinct in having the wing marked with twelve black spots (figure 4), those on r-m crossvein and over second radial cell larger, other smaller spots in middle near apices of cells R_5, M_1, M_2, M_{3+4} and at base and apex of anal cell, behind medial vein near base and just before fork, on vein M_2 just past fork, and in base of cell M_4; macrotrichiae abundant. The mesonotum is dark pruinose gray with blackish hairs arising from small brown dots, with other irregular, scattered, suffuse brown spots; scutellum yellowish with middle dark, four bristles as in ***bella***. Legs dark brown, femora with narrow subapical, fore and mid tibia with narrow and hind tibia with broad subbasal and subapical light rings; tarsal segments with apices narrowly dark, first, fourth and fifth segments on hind legs all dark.

5. **Alluaudomyia needhami** Thomson

(Figs. 2, 10)

Alluaudomyia needhami Thomsen, 1935, Jour. N. Y. Ent. Soc., 43: 287 (♂, ♀, New York; type in Cornell University collection); 1937, Cornell Univ. Agr. Exp. Sta. Mem. 210: 72 (larva, pupa); Johannsen, 1943, Ann. Ent. Soc. Amer., 36: 780.

Length 1.5–2.0 mm., wing 1.0–1.5 mm. by 0.3–0.4 mm.

Basically this is a yellowish-white species with ten-spotted wings. The mesonotum, described as "dark brown covered with grayish-brown pruinescence" by Thomsen, varies in specimens examined, from pure yellow without punctures and with yellowish hairs, through brown with dark dots at the bases of the hairs as in typical ***bella***, to a uniform dark grayish brown in most males. Legs dark, with white markings con-

sisting of fore coxae, bases of femora, narrow subapical femoral bands, narrow sub-basal and subapical bands on all tibiae, except broader sub-basal band on mid tibia; tarsi pale except hind basitarsus and tips of all tarsal segments dark. The wing markings characteristically consist of two prominent black spots, over r-m crossvein and at tip of second radial cell, and eight other less prominent and often very faint and diffuse spots, more or less linear in form, in middle of base of cell M_2, at tip of anal vein, at base of veins M_2 and M_{3+4}, and near apices of veins M_1, M_2, M_{3+4} and Cu_1. Abdomen black below, mostly yellowish above. Several specimens examined, from Virginia and Saskatchewan, were much lighter than usual, with uniformly yellowish mesonotum and the dark leg bands much narrower than the light, with the sub-basal dark band entirely absent on mid and hind tibiae. The Japanese species *aterivena* Tokunaga has wing markings almost identical with *needhami*, but the brownish mesonotum is prominently marked with large, oval, yellowish spots.

Male genitalia (figure 10).—Ninth sternite about a third as long as broad, with broad posterior excavation two-thirds way to base and nearly to sides, the membrane spiculate; ninth tergite broadly rounded caudad, apicolateral processes not developed. Basistyles slender, nearly five times as long as broad, widely separated and with ventral roots poorly defined; dististyles slender and incurved. Aedeagus with slender rounded basal arch at least three times the length of posterior portion, the latter in form of a short, rounded, median posterior lobe. Parameres very long and slender, with hook-shaped basal fourth recurved laterocaudad to within bases of basistyles, distal three-fourths only slightly curved, surpassing apex of ninth tergite and reaching nearly to apices of basistyles, with a very slender, anteriorly directed, hyaline filament about as long as dististyle, remindful of a coachwhip.

Specimens examined:—NEW YORK: Ithaca, June, 1933, L. C. Thomsen (Cornell) 1 ♀ (holotype) 1 ♂ (allotype).

MARYLAND: Plummers Island, June 8, 1914, Schwarz and Shannon, 1 ♂.

VIRGINIA: Mount Solon, July 11, 1950, W. W. Wirth, 1 ♀.

GEORGIA: Newton, June 9, 1948, Emory University Field Station, 1 ♂. Quitman, Sept. 1, 1943, R. H. Foote, 1 ♂.

LOUISIANA: Baton Rouge, Apr. 13, 1947, W. W. Wirth, 1 ♂, 1 ♀.

TEXAS: Richmond, Brazos River, June 22, 1917 (Cornell), 1 ♀.

KANSAS: Topeka, May 6, 1949, McWilliams, 1 ♂.

SASKATCHEWAN: Waskesieu Lake, Prince Albert Nat. Park, June 27, 1950, J. A. Downes, 1 ♂, 2 ♀ ♀.

CALIFORNIA: Blythe, Apr. 8, 1949, W. W. Wirth, 1 ♂.

6. **Alluaudomyia parva** Wirth, new species

(Figs. 5, 6, 8)

A small blackish species with hyaline two-spotted wings, mesonotal pattern of large rounded light spots and regularly banded legs; female with long unequal claws on all legs and two spermathecae; male parameres flattened and expanded in middle, with long recurved ribbon-like apices.

Female.—Length 1.1 mm., wing 1.1 mm. by 0.5 mm.

Occiput black, bordered with pruinose gray; antennae, clypeus and palpi brown; flagellar segments in proportion of 8 : 6 : 6 : 6 : 7 : 7 : 8 : 8 : 12 : 12 : 12 : 12 : 15, segments 3–10 short tapering, 11–15 long tapering, last segment without terminal style. Palpal segments in proportion of 4 : 5 : 9 : 5 : 6, third segment slightly swollen with large, shallow, sensory pit toward apex.

Thorax pruinose dark brown, almost black, with ornate pattern of pruinose gray markings (figure 6); humeral and lateral margins, prescutellar area and a pair of oval submedian spots a third-way back silvery gray pruinose; a pair of long more or less anteriorly interrupted sublateral spots yellowish gray pruinose; scattered long coarse hairs on disc, four long prescutellar bristles. Scutellum dark, ends and sometimes middle more or less yellowish; four strong marginal bristles. Legs including coxae brownish black; femora with narrow preapical

TABLE I

PROPORTIONS OF SEGMENTS OF HIND LEGS OF FEMALE *Alluaudomyia*

	Cx	Tr	F	Ti	T_1	T_2	T_3	T_4	T_5
1. *bella*	20	10	45	45	20	8	4	4	8
2. *footei*	20	10	45	48	20	7	5	4	8
3. *paraspina*	20	10	50	55	20	8	4	4	10
4. *sticlipennis*	20	10	50	45	16	7	5	4	7
5. *needhami*	20	10	50	45	20	8	4	4	10
6. *parva*	18	10	40	35	15	6	4	4	7
7. *downesi*	18	10	35	35	15	5	4	4	7

and tibiae with broad sub-basal and subapical yellowish bands; tarsi pale, hind basitarsus and fifth segment of all legs, black; proportions of segments of hind legs as in Table I. Claws simple and unequal on all legs, the anterior claw half to three-fourths as long as posterior claw, the latter as long as fifth segment.

Wing (figure 5) hyaline, anterior veins clear, a small but distinct black spot at end of second radial cell and a less distinct spot formed by the blackened vein forming front margin of first radial cell. Macrotrichiae scanty, a few in two lines in each of cells R_5, M_1 and M_2. First radial cell about half the length of second and greatly narrowed; media forking at basal third, vein M_2 narrowly interrupted at base. Halteres white.

Abdomen velvety black, apices of tergites very narrowly yellowish banded, seventh and eighth segments more or less whitish. Spermathecae two, rather large and ovoid.

Male.—As in the female, with the usual sexual differences; antennal plume brown. Genitalia (figure 8) broader than long; ninth sternite twice as broad as long, with deep mesal excavation, the posterior membrane spiculate; ninth tergite short, apicolateral processes not developed. Basistyles broad and tapering, simple; dististyles long, slender and sinuate with slender tips. Aedeagus a narrow semi-circular

sclerotized arch with length about three-fourths basal width, apex with a median knob-like, ventrally curved lobe. Parameres with a pair of stout basal apodemes, the inner ends enlarged and C-shaped; stems a pair of submedian processes extending past tips of basistyles, gradually flattened and widened caudad, with apices abruptly recurved ventrolaterad and greatly narrowed ribbon-like.

Holotype, ♂, *allotype*, Crystal River, Citrus County, Florida, June 7, 1949, Hudson (light trap) (Type No. 60952, USNM). Paratypes, 3 ♂♂, 1 ♀, same data as type; 7 ♂♂, 6 ♀♀, Innerarity Point, Escambia County, Florida, May-July, 1949–50, Rathert.

Allied to *downesi*, n. sp., and distinct from the other Nearctic species in its small size and body proportions, the reduction of the wing spots to the two on the radial cells, the reduction of macrotrichiae, and in the type of leg banding. The allied species, *downesi*, differs chiefly in its lack of mesonotal pattern, lighter legs, and abdomen with pattern of large pale spots.

7. **Alluaudomyia downesi** Wirth, new species

A small yellowish-brown species with hyaline, two-spotted wings, grayish pruinose, punctate mesonotum with poorly defined pattern, yellowish regularly brown-banded legs and abdomen with lateral white spots.

Female.—Length 1.2 mm., wing 1.4 mm. by 0.7 mm.

Head brown, occiput black with pruinose gray border; antennal and palpal proportions as in *parva*.

Mesonotum pruinose light brown; humeral corners, a pair of submedian discal spots and prescutellar area suffused with silvery gray, a pair of lateral dark brown spots above wing bases. Mesonotal hairs long and strong, mostly in three rows, the integument with dark brown dots at base of each hair. Scutellum brown in middle, ends yellow, with four long brown marginal bristles. Postscutellum and pleura brown; latter darker above coxae. Legs yellow, coxae, broad median bands on femora, knees, narrow median and apical rings on tibiae, and hind basitarsus, brown. Proportion of segments of hind legs as in Table I; claws long and unequal on all legs, the longer claw as long as fifth segment, shorter about half as long.

Wings hyaline, anterior veins yellow; a small black spot on anterior margin of first radial cell and one at apex of second; a faint suggestion of darkening of the posterior veins. Macrotrichiae sparse, confined to two rows in each of cells R_5, M_1 and M_2; media forking at basal fourth, M_2 complete at base. Halteres white.

Abdomen pruinose brownish black; in holotype tergites each with two sublateral and two lateral large white spots, segments seven and eight mostly white. In paratype, white spots less well defined.

Holotype ♀, Mount Solon, Augusta County, Virginia, July 11, 1950, W. W. Wirth (light trap) (Type No. 60953, USNM). *Paratype* ♀, Kingsmere, Gattineau Park, Ottawa, Canada, July 14, 1950, J. A. Downes.

Closely allied to *parva*, n. sp., from which it is readily separated by the light brown, grayish pruinose, minutely punctate mesonotum,

yellowish legs, the femora yellowish at base, and the lateral spots rather than apical bands on the abdomen. I am pleased to name this species in honor of Dr. J. Antony Downes of the University of Glasgow, whose trip to Canada resulted in the discovery of many new and interesting Heleidae.

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FOREST ENTOMOLOGY, by SAMUEL ALEXANDER GRAHAM. xii+351 pages, 85 figs., 12 tables. McGraw-Hill Book Company, Inc., New York, 1952. Price, $6.00.

Dr. Samuel Graham is certainly to be congratulated on his fine attempt to bring the subject matter of forest entomology up to date in his third edition. Students and instructors of forest entomology, research workers and practicing foresters welcome the revision of material presented in former editions and the appearance of many new chapters.

The history of forest entomology has been briefly outlined and brought up to date. Particular emphasis has been placed on contemporary work and the organization of state and federal agencies engaged in forest entomological research, survey and control programs. The Forest Pest Control Act of 1947 has broadened the activities of forest entomologists. Dr. Graham has traced the evolution of this important piece of legislation and has explained its significance.

Dr. Graham's treatment of the subject in previous editions has stressed the ecological approach. It was gratifying to this reviewer to find that in the condensation and reshuffling of material, there still emerged a strong and adequate treatment of the basic principles of insect ecology and its application to forest entomology. The addition of the new chapter on forest insect surveys and the complete revision of modern chemical control measures have added much to the new edition. The expansion of the discussion of indirect control by silvicultural practices and the devotion of a whole chapter to the subject is especially welcome to those whose background in silvics is meager. The bibliography, although not extensive, does contain most classical papers on the subject and many new important works have been added.

It is of interest to note that this 1952 edition has been removed from the publishers series in the Zoological Sciences and placed in the American Forestry Series.—H. G. SIMKOVER.

COLONIES OF ANTS IN A LOCUST WOODS

A. E. HEADLEY
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General collecting of ants in an area is apt to disclose only the more conspicuous species. A more concentrated survey of a habitat, such as is made during population studies of a single species, usually reveals other ants which are inconspicuous because they are small in size and numbers or are nesting in obscure places.

Recently I had spent considerable time in a locust grove in Seneca County, Ohio while digging colonies of *Aphaenogaster fulva aquia* Buckley (Headley, '49) for a population study. During this time several species of ants were found which were considered rare to the region. It became apparent that any study which would aim at a total survey of colonies of ants in a woods would augment the more concentrated studies of single species and thus give another aspect to the discussion of societies of ants in a restricted area. So the problem became "How many species of ants are there in the woods and what is the abundance of colonies of each species?"

The main studies were made on August 21, 23, 24, 25, 1948. To check results the work was repeated on June 11, July 9 and September 7, 8, 9, 1949. Since the second year's study simply verified the first and the variety of dates made no particular difference, except in the state of development of brood, the first year's results will be reported in considerable detail and the second more briefly.

In 1950 similar studies made in a nearby beech-maple wood gave sharply contrasting conditions which will be discussed later in the paper. Following is the 1948 work.

The technique adopted for making the survey was that of staking off a square meter and studying the ants within it, then staking a second meter adjacent to it and continuing this until 15 square meters extending in a line almost the entire width of the woods were staked and studied. This strip was typical of the woods in general but did not extend to its edge where conditions began to change. The woods was composed of young, close-growing locust trees which allowed only flickering sun but did not give the constant shade of a maple or oak woods. The most typical ground plant was tall blue lettuce (*Latuca spicata*) which grew six to seven feet tall. This, together with ragweed, catnip, goldenrod, nettle, nightshade, raspberry and elderberry bushes, young boxelder trees, sorrel, and plantain provided a fairly dense stand of vegetation. Beneath, the ground was covered with a trashy layer of twigs, dead leaves, and fallen stems of tall blue lettuce and elderberry. The soil was loose and intertwined with roots for several inches and then became a solid loam-clay.

At the beginning of the study of each square meter, cake crumbs were scattered over the plot to find out how many ants were walking over the surface of the ground and to locate as many nests as possible

CHART I

NUMBERS OF COLONIES OF ANTS FOUND ON 27 SQUARE METERS IN A YOUNG LOCUST WOODS

Digging dates	1948																1949													
	August 21, 23, 24, 25																June 11			July 9			September 7			September 8			September 9				
Plots (each one sq. meter)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total Colonies	1	2	3	4	5	6	7	8	9	10	11	12	Total Colonies	Total Colonies 1948–1949
Ponera c. pennsylvanica	F6	F5	8	F9	15	8	3	5	5	4	4	3	6		5	86	9	16	4	4	6	3	10	19	13	3	14	8	109	195
Stigmatomma pallipes	5		2	1	1	1	3				1					14	1	2					1	2	1	1		2	10	24
Stenamma brevicorne	F	F3	F1	F2		F2	F1	F	2	F2	F1	F2	1			17	F3	F3	F2	F	F	F2	1	F2	F2	F2	F1	F	18	35
Prenolepis imparis	F1	F	1	F1			F	F1				1	1		1	7	F1	F	F1				F	F2	F1		F 1	F1	7	14
Aphaenogaster fulva aquia	F	F1	F	F1	F1	F3	F	F						F	F1	7	F1		F1										2	9
Brachymyrmex heeri depilis								F1	F1							2														2
Tapinoma sessile				F		F	F		F1	F		F1	F	F		2	F	F	F				F	F						2
Lasius alienus americanus		F	F1	F1		F			F	F			F2			4			F1	F	F2					3	2		8	12
Myrmecina g. americana																	1				F	F				1	1		3	3
Formica fusca subserica					F		F			F												F								
Camponotus h. pennsylvanicus											F																			
Camponotus caryae		F							F		F		F																	
Crematogaster lineolata													F				F	F												
Lasius claviger		*F	*F	*F						*F	*F							*F1		*F1	*F		*F	*F1	*F				3	3
Lasius u. m. aphidicola												*F																		
No. of colonies per sq. meter	12	9	13	15	17	14	7	7	9	6	6	7	10	0	7	139	16	22	9	5	8	5	12	26	17	10	19	11	160	299

Numbers indicate colonies in a plot of one square meter.
F—indicates ants found foraging on the plot. *F—indicates ants foraging beneath the surface.

before the area was disturbed by the cleaning up of surface debris. While the ants were finding and carrying cake crumbs to their nests, types of vegetation were noted and a record was made of the kind and number of ants on the ground. Then vegetation, decaying limbs, stems, leaves, and any other debris were removed. At this level there were many land isopods and small harvestmen together with an assortment of small beetles and spiders living on or in the loose surface soil. By this time nests of foraging ants such as *Aphenogaster fulva aquia* Buckley, *Stenamma brevicorne* Mayr, and *Prenolepis imparis* Say were located by watching the workers carry cake crumbs to them. Then the surface soil was diced away a bit at a time to a depth of two to three inches. This revealed entire nests of many species and the surface chambers of nests which extended deeper. The locations of all colonies so discovered were plotted on graph paper.

This technique yielded results which were surprising. First there were many more colonies than had been suspected, 139 being found in the 1 x 15 meter area. Second, eight species of ants were found nesting in the plots and 14 species were foraging there and this seemed like a great number for so small an area consisting of one type of habitat. Third, it had not been supposed that *Ponera coarctata pennsylvanica* Buckley would be the most abundant ant in number of colonies but 86 nests of the entire 139 were of this species. Furthermore *Ponera* was encountered in every square meter except one (which yielded no nests at all). Next in abundance were *Stenamma brevicorne* Mayr (17 colonies) and *Stigmatomma pallipes* Hald. (14 colonies). None of these three had been considered common in the woods and *Stigmatomma* had not been recorded at all. (Number of colonies and number of individuals must be distinguished. One nest of *Prenolepis* would undoubtedly contain more ants than all of the *Ponera* nests.)

DISTRIBUTION OF NESTS IN THE PLOTS

As is shown by Chart I, colonies were fairly evenly distributed over the 15 plots but the first five had slightly more nests while number 14 had none at all. This seems to be due to a hardly perceptible depression which began in the ninth meter and reached a depth of about five inches in the fourteenth. Although five inches is a very small dip, yet in this woods it represented the lowest spot where, in the spring, water may collect and stand for several weeks. In plot 15 there was an abrupt rise so that, while no nests were found on its half next to the fourteenth plot, seven colonies were present in the other half. It was found that in these lower, more moist plots a number of colonies nested in materials above the ground while in the higher eight plots no above-ground nests were found.

The most thickly populated square meter yielded 17 colonies (15 of which were *Ponera*) while the mean for the 15 plots was 8.13 colonies. Aside from the plot which had no nests the smallest collection for a square was six colonies.

Ponera coarctata pennsylvanica Buckley colonies were by far the most numerous, making up 86 of the total 139. They were distributed in every plot except number 14 which had no nests at all. Yet ordinary

collecting methods give the impression that *Ponera* is not a particularly common ant.

The time of study, late August, proved a good season for collecting *Ponera* because at that time there were many conspicuous yellow pupae and the ground was dry and hard enough so that chambers did not crumble to pieces when opened, thus insuring a more complete collection.

An attempt made to count *Ponera* individuals was not too successful. The 217 workers found in the 86 nests was undoubtedly a very low undercount. Workers were difficult to see because they were ground-colored and moved slowly or not at all. Eggs were not found and there were few larvae. The mean of 11.8 pupae per colony was probably fairly correct. The largest colony contained 36. When cocoon coverings were removed under a microscope, pupae were found to be workers, males, and females. In one colony of 15 workers and 18 pupae 10 of the 18 proved to be winged forms. Adult males and females were also present, 22 being collected in four colonies. Flight time was evidently still in the future.

Ponera nests were all near the surface. Many were destroyed on being chopped into, but 49 distinct nests in the ground were at the following depths: 11 were at ¼ inch, 25 at ½ inch, 3 at ¾ inch, 10 at 1 inch. Chambers were small, usually about ¼ inch long x ¼ inch wide x ¼ inch high. One large cavity filled with pupae was ½ x ¼ x ⅜ inches. Occasionally no distinct chamber could be found but the ants and brood were distributed along crevices in the soil. Most nests were associated with nothing but soil but a few were found among roots of tall blue lettuce or dandelion. In the meters which were lower than the surroundings, six *Ponera* nests were found aboveground. One was under the bark of a locust twig where a small cavity had been made in the wood; one was in a definite chamber in a locust twig without bark. This chamber was ½ inch wide and ¼ inch high and had a gallery sloping downward to the ground. One colony used a half butternut shell sunk into the ground. The ants had hollowed out the soil from one of the four cavities except for a very thin covering which contained a clean round hole just large enough for a *Ponera* to pass through.

Stigmatomma pallipes, a truly hypogeic ant, is usually found by turning over stones. In this woods devoid of stones it had not been suspected. However, by the technique of scraping off the first two inches of soil 14 colonies were found in seven plots. Most of the ants were about an inch below the surface and were in even smaller groups than were *Ponera*. Adults ranged from one to six and pupae from two to 17. No eggs or larvae were seen. Winged ants were found three times, nine in one nest and one each in two others. One colony of three workers and 13 pupae occupied a definite little chamber ½ x ¼ x ⅜ inches. Another colony of six workers, 17 pupae, and one winged ant had a chamber 1–¼ inch long, ¼ inch wide, and ⅜ inch high. This chamber was connected with the surface by a gallery 1/16 inch in diameter.

The 17 *Stenamma brevicorne* colonies were distributed over 10 plots. Since workers were actively foraging at the surface and were numerous in each colony they were quite conspicuous during the study. No attempt was made to collect entire colonies and nests were not excavated beyond the three inch level. Larvae and pupae were constantly present and winged ants were present in nine colonies.

Prenolepis imparis nests were found on seven plots. Workers and pupae were present but the season was too late for larvae and eggs. Since males and females are overwintered they were probably present deep in the nest. No attempt to dig the nests was made but Talbot ('43) reports that they may extend as deep as three or four feet and have an average population of about 1500.

Aphaenogaster fulva aquia populations have been studied in this same woods and had been thought to be quite numerous. However, they were found on only five plots and of the seven colonies two were merely dealate queens which were the product of this summer's flights. *Aphaenogaster* colonies average about 650 individuals and nests vary from those on the surface to a depth of three feet (Headley '49).

Brachymyrmex heeri depilis Emery nests spread over considerable ground and showed many surface runways connecting numerous chambers just beneath the surface. The larger of the two nests found extended over 24 x 18 inches of soil while the smaller one covered an area 7 x 3 inches. Within this space were several entrances and numerous little ditch-like runways on which were many workers. In the chambers below were workers, pupae, males and females. Evidently *Brachymyrmex* workers do not wander far from the nest for they were found only on the two plots where the nests were located.

Tapinoma sessile workers foraged over eight plots but only two colonies were found and both of these were aboveground. One young colony consisting of a queen, two workers, and a little pile of larvae was found in a goldenrod gall lying on the ground. The other, a larger colony with pupae, was nesting between layers of leaves.

Lasius alienus var. *americanus* Emery was represented by dealate females only. The four found were one to two inches below the surface and had hollowed out small chambers. At the time of digging *Lasius* flights were still going on so the queens had undoubtedly been there for a few days only. No mature colonies were found but they were undoubtedly nesting in the nearby area since 35 workers were found foraging on seven plots.

FORAGING ANTS

A count of workers foraging on the surface of the plots put *Stenamma* high with 57 individuals scattered over 10 plots, *Aphaenogaster* next with 46 ants on 10 plots, and *Lasius alienus americanus* third with 35 ants on seven plots. (Of course abundance of foraging ants varies greatly with time of day, temperature, humidity, etc.; Talbot, 1946.) In contrast *Stigmatomma* was never found at the surface and only four *Ponera* were seen. Ants nesting in trees or at the woods' edge invaded the plots. Thus, *Camponotus caryae* Fitch was found four times, *Formica fusca* var. *subsericea* Say, five, and *Camponotus herculeanus pennsylvanicus* De Geer and *Crematogaster lineolata* Say once each. Two species were found foraging beneath the surface of the soil. *Lasius umbratus mixtus* var. *aphidicola* Walsh was encountered only once, but 18 individuals of *Lasius claviger* Roger were dug out.

WINGED ANTS

At this time of year (late August) flights had not yet occurred for *Ponera*, *Stigmatomma*, *Brachymyrmex*, and *Stenamma* and all of these

forms had winged males and females in some of the colonies. *Prenolepis* is known to overwinter males and females so presumably they were present deeper in the ground. *Tapinoma* and *Aphaenogaster* flights were past and two of the seven colonies of *Aphaenogaster* were represented simply by isolated females. *Lasius alienus americanus* flights were in progress and all of the four "colonies" found were single dealate females. All of the other colonies contained pupae, while larvae were found only in nests of *Stenamma*, *Aphaenogaster*, and *Tapinoma*. *Aphaenogaster* is known to overwinter eggs as well as larvae.

DISCUSSION

In 1949 the problem was repeated on a smaller scale and at different intervals of the growing season to see if results would be consistent. Three plots were dug in the early part of June; three in July and then six plots were cleared during the first part of September.

The techniques used were the same and the plots chosen were approximately a meter from the original study and roughly parallel to it. The woods was chosen in the first place because the vegetation was consistent year in and year out making light, humidity, temperature, and ground conditions uniform.

The results were very similar to those of 1948. In twelve square meter plots there were 160 colonies of ants. *Ponera* was again by far the most abundant in terms of colonies, there being 109 in the 12 plots. *Stenemma* was next with 18 colonies and *Stigmatomma* third, with 10 colonies. Of the eight species found nesting in 1948 six were again encountered. No *Brachymyrmex* or *Tapinoma* nests were located in 1949, however *Lasius claviger*, which in 1948 had been represented by foraging ants only, was found nesting. An ant new to the list, *Myrmecina graminicola americana* Emery, was dug three times. This made a total of 10 species living in the plots. Development of brood was indicated by *Ponera*. In early June workers only were found. By July there were larvae and pupae many of which were ready to mature soon. In September the winged forms were gone (only one male and one female were found), while workers included a number of callows newly emerged from the pupa and a few pupae.

Combining the two year results we find that in 27 plots of one square meter each there were 299 colonies of ants. This is a mean of 11.07 per square meter and indicates a possibility of there being 56,125 ant colonies nesting in the soil of the locust woods which measures 65 times 78 meters.

Aphaenogaster fulva aquia colonies, taken previously from this woods, averaged 650 individuals (adults, pupae, larvae, eggs) per colony. Nine *Aphaenogaster* colonies were found in the 27 plots, giving a possibility of there being 1673 colonies of the ant living in the woods and a consequent population of this species of over 1,080,000 individuals. Figuring *Prenolepis* populations in the same manner we find a possibility of 2,636 colonies and almost 4,000,000 individuals. If average populations of other species were known an estimation of the total ant population could be worked out.

Habitat conditions were uniform throughout the woods and the abundant species were widely distributed. As can be seen by the two

charts, *Ponera* colonies occurred in every plot except one, *Stenemma* was found on 19, *Stigmatomma* on 14, and *Prenolepis* on 13 of the 27 plots. *Brachymyrmex* was the most restricted, since the two colonies were close together and workers did not forage across other plots. In contrast, *Tapinoma* which also nested in only two plots wandered rather widely. *Lasius claviger*, with three nests, traveled underground over 11 plots and thus, although never seen at the surface, was actually less restricted than was *Myrmecina* which nested in three plots and foraged over two more.

This technique of limiting the study to ants nesting in or foraging over the soil revealed all but two species known to exist in the woods. Previously, *Leptothorax curvispinosus* Mayr had been seen on leaves and one nest of *Aphaenogaster tennesseensis* Mayr was known to nest in a large log near the woods' edge.

The question was raised as to whether ants nesting in soil beneath the locusts were more or less numerous than in other woods. To test this another type of wood, this time a beech-maple climax, was selected for a survey. This was a dense, shady woods made up of tall old maple and beech trees together with scattered oak, walnut, hickory, elm, buckeye, and linden. There were no high weeds because of the constant shade and the herb layer was predominantly spring blooming plants such as false solomons seal, blood root, jack-in-the-pulpit, hepatica, and anemone. In places young maple trees, two to six feet tall were numerous but there was no shrub stratum. The soil was covered with thick layerings of leaves in most places but they harbored no abundance of small arachnids and insects as did the litter in the locust woods. Earthworms seemed equally abundant in the two. Many large logs in all stages of decay were scattered about.

Under these conditions the soil became a poor habitat for ants and instead of an average of 11.07 nests per meter found in the locust woods 10 square meters dug at random in 10 parts of the woods on June 20 and 21, 1950 contained only 18 colonies or 1.8 per square meter. Thirteen of the 18 were of *Lasius flavus nearcticus* Wheeler and this ant was widely distributed in the woods, being found in seven plots. Furthermore, it was restricted to soil, occupying little chambers one half to two inches below the surface and foraging out for a foot or more along small roots. *Stigmatomma pallipes* was found once in a little chamber just below the surface, three colonies of *Aphaenogaster fulva aquia* nested in the soil, as did one of *Ponera coarctata pallipes*. One *Aphaenogaster tennesseensis* queen was picked up a foot from a disturbed *A. fulva aquia* colony but whether she had been associated with it could not be told.

Thus, the technique which discovered abundant ants in the locust woods gave a picture of ant scarcity in the beech-maple. However, the picture changed as soon as other methods of collection were employed and it was soon discovered that *Ponera* was extremely common in this woods, as well as in the other, only now it was found above the soil: under the bark in solid logs, all through thoroughly decayed ones and in acorns and hickory nuts. Next in abundance was *Aphaenogaster fulva aquia*, again most numerous in logs in all stages of decay.

These two species were found everywhere in the woods and seemed its most characteristic forms. Large solid logs yielded several colonies

of *Camponotus herculeanus pennsylvanica*, *C. herculeanus ferrugineus* Fabricius, *C. caryae* and *Crematogaster lineolata*. Two, raised off the ground, contained nests of *Aphaenogaster tennesseensis*, while *Leptothorax longispinosus* workers were found walking along several logs. Acorns, and the less common hickory nuts, proved good housing for small colonies and in these were found colonies of *Leptothorax curvispinosus* and *Myrmecina graminicola americana* as well as *Ponera*, *Aphaenogaster* and *L. longispinosus*. Small twigs also housed *L. curvispinosus*. Along a bank above a stream, where the soil had been eroded down to clay, there were several colonies of *Prenolepis imparis* and *Formica fusca subsericea* and along a border next to a field workers of *Tapinoma sessile* and *Formica pallidefulva schaufussi incerta* wandered into the woods.

Thus, of 16 species found in the beech-maple woods only two were characteristic of the soil: *Lasius flavus nearcticus* and *Stigmatomma pallipes*. *Ponera* and *Aphaenogaster*, which nested abundantly in the soil of the locust woods found it unsuitable and adapted themselves to a different habitat aboveground without diminishing in numbers. In contrast, *Stenamma* seemed crowded out entirely and *Stigmatomma* was reduced in numbers.

SUMMARY

An attempt was made to determine the abundance of colonies as well as the number of species of ants in a small woods. A locust grove was selected because it had previously been found that most of the ants in it nested in the soil and colonies could be counted by scraping away the soil surface.

In twenty-seven square meter plots fifteen species of ants were found, ten nesting and five more foraging from nests in trees or at the woods' edge. In the plots 299 colonies of ants were found giving a mean of 11.07 colonies per square meter and a possibility of 56,125 ant colonies nesting in the soil of the 65 x 78 meter woods. *Ponera coarctata pennsylvanica* was the most abundant species.

In contrast, this technique of counting soil inhabiting ants did not give a true picture of colony abundance in a beech-maple woods because here the soil seemed unsuitable for most species and most ants were found nesting aboveground in decaying logs or in acorns and hickory nuts.

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A NEW PHEIDOLE (HYMENOPTERA: FORMICIDAE) FROM FLORIDA[1]

A. C. COLE
University of Tennessee, Knoxville

Pheidole sitarches littoralis n. subsp.

Holotype, major (Cole collection, No. E-138).—Differing from the typical *sitarches* and its other known subspecies in the following characteristics: It lacks the transverse delicate rugules on the occipital lobes of the head, giving the head a more shining appearance; the coarse longitudinal cephalic rugae are more irregular and form weak reticulations; the hairs on the occipital lobes of the head are shorter, stouter, and more numerous; the pronotum is more coarsely and irregularly rugose; a few fine rugae extend transversely between the bases of the epinotal spines; the thoracic hairs are more pointed and somewhat more delicate, being not at all clavate.

Paratype, minor.—Differing from previously described forms of *sitarches* in the posterior half of the head which is striatopunctate and in the much darker color of the entire body.

Type locality.—Lido Beach, Sarasota, Florida. The holotype, 59 paratype majors, and numerous paratype minors were collected by the writer, December 24, 1950.

Deposition of types.—The holotype is in the collection of the writer. Paratypes are to be deposited in the Museum of Comparative Zoology, U. S. National Museum, American Museum of Natural History, and in the collections of Dr. W. S. Creighton and the writer.

Habitat.—Several colonies were found in unshaded areas of pure sand on the upper beach. Each nest was marked by a small flattened crater of sand approximately 3.0 cm. in diameter. The lower nest chambers were at a depth of about 7.0 cm.

Affinities.—After a cursory examination of both castes the writer suspected *littoralis* of being a member of the *pilifera* complex. Through the courtesy of the Museum of Comparative Zoology types of *sitarches* and its subspecies *campestris* and *soritis* were examined. The writer became convinced that the new subspecies is most closely related to *sitarches* and its known subspecies which had been the contention of Dr. W. S. Creighton when he had examined the specimens previously. The new subspecies seems to be much more closely related to *sitarches* than to *pilifera*, particularly in the sculpturing and contour of the head and in the shape of the postpetiole and the humeral angles of the prothorax. It seems to be more like the subspecies *campestris* than *soritis*. *Pheidole pilifera* and its subspecies have the occipital margin of the head more deeply excised, the head much less rugo-reticulate,

[1]Contribution No. 50, Department of Zoology and Entomology, University of Tennessee, Knoxville.

the lateral connules of the postpetiole very well developed, and the humeral angles of the prothorax pronounced.

The real problem is that of determining whether the new ant is a subspecies of *sitarches* or a species in its own right. If it is assumed that *sitarches* is the most closely related species to *pilifera*, the writer is more inclined to classify the new ant as a subspecies of *sitarches*. The new ant probably represents a peninsular population which is disjunct from populations of *sitarches* and its other known subspecies. Further collections in other areas may tend better to clarify the matter.

There follows a key for the separation of the known forms of *sitarches*.

1. The entire thoracic dorsum, petiole, and postpetiole of the minor opaque, densely and rather evenly punctate 2
   Pronotum of the minor shining, not punctate; epinotum, petiole, and postpetiole opaque and punctate 3
2. Head of the minor coarsely and evenly punctate posteriorly; hairs on promesonotum of the minor very blunt and strongly clavate; transverse rugules on occipital lobes of the major present ..... **sitarches** subsp. **campestris** Wheeler
   Head of the minor finely striatopunctate posteriorly; hairs on promesonotum of the minor less blunt, not clavate; transverse rugules on occipital lobes of the major absent ..... **sitarches** subsp. **littoralis** nova
3. Head of the minor not striate posteriorly; pronotum of the major finely and rather densely and unevenly punctate, the transverse rugae not prominent ..... **sitarches** Wheeler
   Head of the minor striate posteriorly; pronotum of the major not noticeably punctate, the transverse rugae prominent ..... **sitarches** subsp. **soritis** Wheeler

The writer is grateful to Dr. W. S. Creighton, Dr. M. R. Smith, and Mr. E. O. Wilson for their opinions and suggestions, and to the Museum of Comparative Zoology for the loan of types.

STANDARD VALUES IN BLOOD. Erretr C. Albritton, editor. Prepared by 640 contributors and reviewers under the direction of the Committee on the Handbook of Biological Data, American Institute of Biological Sciences, AF Technical Report No. 6039, Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio. ix+199 pp. 1952.

This useful manual is the first part of the *Handbook of Biological Data* sponsored by the American Institute of Biological Sciences and as such is of significant importance to all aspects of biology. Included in this first part are 101 well-organized and easily used tables presenting a wealth of quantitative data on the constituents and properties of blood. The vast majority of the data concern the bloods of man, laboratory mammals, and the common domestic animals. There are a few data on the lower vertebrates and virtually none on the invertebrates. This deficiency is quite unfortunate in a *biological* handbook. Perhaps it is somewhat the reflection of the more fragmentary nature of the data on invertebrate groups, including insects, as well as the fact that significant comparisons with vertebrates are few. It is to be hoped that a subsequent of the handbook will summarize the available quantitative data for the pertinent invertebrate groups. It is to be hoped further that other parts of the handbook will soon appear and that they will be able to attain the same degree of concise useful organization developed in the first part.—Donald S. Farner.

We learn, in correspondence, that this report will be published in more permanent form by the W. B. Saunders Company, Philadelphia, and that it should be available by or shortly after the time this review is published.—Ed.

THE LARVAL MORPHOLOGY AND CHAETOTAXY OF THE CULEX SUBGENUS MELANOCONION

(Diptera, Culicidae)[1]

RICHARD H. FOOTE

INTRODUCTION

With the exception of those species of *Melanoconion* said to occur within the continental United States, taxonomic work on the immature stages of this group as it occurs throughout the New World is conspicuous by its absence from our entomological literature. The adults form a systematic group long held to be difficult in which to work, and until the appearance of a recent revision by Rozeboom and Komp (1950), the only significant work in this direction has appeared in the monographs of Theobald (1903), Dyar (1928), Edwards (1932) and in numerous separate papers by Dyar, Dyar and Knab, Komp and others. Absence of interest in this group, perhaps occasioned by its lack of medical importance, has contributed to this situation, but more serious have been the limitations imposed by the dearth of material for study. The work leading to the recent revision of Rozeboom and Komp mentioned above resulted in the rearing of a large number of species in this group in a laboratory close to their collection sites in northern South America, the population center of the subgenus. By carefully associating cast larval and pupal skins of a series of specimens of many species with the corresponding adult males, they have made a study such as this possible for the first time by providing immature stages which are identified by means of corresponding male terminalia. It is expected that a systematic review of the species based on fourth instar larvae and pupae will appear at a later date.

The present study is deemed desirable from two points of view. In the first place, some of the information presented here is surprisingly enough not to be found in our literature, and is fundamental to a taxonomic revision of the subgenus, as it is in any other group of animals. Secondly, it is designed to provide not only the material for use in distinguishing species and groups of lower categories, but serves as a foundation on which a subgeneric structure may be built. Our conception of the subgenus *Melanoconion* as based on larval characters is badly in need of reinforcement.

REVIEW OF LITERATURE

Morphological and chaetotactic studies of culicine larvae have never received the careful attention which has been bestowed on those

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of *Anopheles*. This lack of critical work has resulted in a great deal of confusion with regard to the nomenclature and homologies of characters, such as the small thoracic and abdominal hairs, which might well be of taxonomic importance among certain groups of culicines, and which are commonly used to distinguish even our most common species of anophelines.

Dyar, Knab and other early taxonomists restricted their larval descriptions to include only the salient features of the terminal abdominal segments, notably the air tube and its tufts, the very long hairs which could be more or less easily observed, and the features of the comb and comb scales. It was not until Lang (1920) proposed names for the most prominent head hairs of culicine larvae that any serious attempt at homologizing them with those of *Anopheles* was made. Following this, Martini (1923) attempted to number all of the hairs of *Aedes nemorosus* he regarded as being of possible taxonomic importance. His system of numbering head hairs was subsequently followed with few modifications by Marshall (1938) for culicines, by various anopheline taxonomists, and is the one I have adopted in the present paper. Martini's system for numbering hairs of the thorax and abdomen of *Aedes nemorosus* has undergone revision through the work of Edwards and Given (1928), Puri (1928), Root (1924, 1932), Barraud (1934), Hopkins (1936), Marshall (1938) and Senevet and Abonnenc (1939).

Since most of the workers cited above confined their observations to the chaetotaxy of the thorax and to the long lateral abdominal hairs, the large gap in our knowledge occurs in the naming and numbering of the fine dorsal and ventral hairs of abdominal segments I through VII. This has been done here in the hope that these characters may be used by future workers in the taxonomy of culicine larvae.

Two outstanding papers, those by Cook (1944) and by Farnsworth (1947) have recently added to our more complete knowledge of the morphology of the anopheline and culicine head capsule. I have followed the terminology of Cook in the treatment of these head characters insofar as possible. Dodge (1945) and Wirth (1945) have pointed out the taxonomic value of various characters in the separation of larvae in the subgenus *Melanoconion*. Belkin (1950) has recently proposed a revised system for the nomenclature of the hairs of culicine larvae; these changes have not been followed in the work presented below.

TECHNIQUE

Because some of the species available for this study were represented only by mounts in which the medium had deteriorated over a period of years, and others only by specimens which were too dark to examine for internal structures or for ventral hairs, it was necessary to remount many of the larvae. In these cases the following regimen was used to produce slide mounts which proved to lend themselves admirably to critical examination:

1. Data were separately recorded for all old slides.
2. Slides were immersed in full strength xylene until the specimens floated free in it.

3. Specimens were carefully removed with a large-mouth dropper to Stender dishes containing 95% alcohol, and allowed to remain for one hour.
4. After being transferred to 70% alcohol for one hour, specimens were washed in water and immersed in 10% potassium hydroxide. At first they shriveled and darkened but were left until the thorax and abdomen were fully rounded and the cuticle transparent.
5. The larvae were then washed in distilled water and placed in glacial acetic acid to dehydrate, each for two hours.
6. Transferrence to cellosolve and beechwood creosote, each for two hours, preceded remounting on a new slide in balsam under a No. 1 coverslip. The slide was immediately labeled and set away to harden.

In some cases perfect rotundity of thorax and abdomen was retained in a finished mount by placing the cleared larva in a pool of balsam held in a 3/16-inch hole drilled through a thin piece of celluloid which had previously been cemented to the slide. This hole was slightly smaller than the 15 mm. round coverslip which was completely supported by the celluloid around the perimeter. Use of this method allowed the ventral and dorsal sides of the body to maintain their original curvatures, and the ventral and dorsal hairs and other characters remained in their normal life-like relations with one another, completely removing any confusion in this regard.

Dehydration with glacial acetic acid prevents hardening of the specimens and consequent loss of hairs. These mounts were found to be highly superior to cast larval skins for examination of thoracic and abdominal chaetotaxy, although the head capsule of a cast skin is perhaps better suited to a study of head hairs.

In another method of preparation, only the heads of several species of larvae were left in 10% potassium hydroxide for about 48 hours, or until the mentum was nearly transparent, then mounted ventral side up in the manner described above. This somewhat drastic procedure is the only manner in which such characters as the prementum, mentum, auleum and details of the mandibular teeth can be demonstrated *in situ* (see below). The construction of the head capsule and details of its larger structures, the mandibles and maxillae, were studied in dissected capsules of cast skins. After removal from the slide in xylene, they were transferred to a fresh slide and dissected in a drop of beechwood creosote, after which the various parts were laid in the desired positions on a thin film of fresh balsam on a different part of the slide and set in an oven at 40 degrees C. for 24 hours before being covered with a coverslip.

MATERIAL

Rozeboom and Komp (1950) have combined both of Dyar's (1928) subgenera *Mochlostyrax* and *Melanoconion* under a single subgenus *Melanoconion*, but have retained Dyar's division of both of these subgenera into sections based on the shape of the male clasper. The material upon which this study is based is distributed throughout the subgenus as follows:

Subgenus *Melanoconion* (of Rozeboom and Komp)
Subgenus *Melanoconion* (of Dyar)
Section *Gnophodeomyia*
aikenii ..... 12 specimens
Section *Melanoconion*
atratus 100
dunni 15
commevynensis 2
Subgenus *Mochlostyrax* (of Dyar)
Section *Mochlostyrax*
caudelli 1
alogistus 1
rooti 1
innovator 2
unicornis 2
pilosus 110
Section *Choeroporpa*
bastagarius 8
batesi 5
chrysonotum 15
conservator 1
conspirator 7
distinguendus 1
educator 22
egcymon 1
elevator 9
erraticus 16
inhibitator 14
iolambdis 25
lucifugus 19
mistura 16
mulrennani 27
mutator (?) 1
peccator 75
phlogistus 10
plectoporpe 1
serratimarge 2
sursumptor 4
theobaldi 2

MORPHOLOGY

Head

Viewed from above, the head capsule of the ***Melanoconion*** larva is wider than long, its proportions being about 9 to 4 (fig. 1). The eyes (e) are situated in a lateral position on the widest part of the head, slightly behind the center, and are usually roughly triangular in shape. Most of the dorsal surface is occupied by the clypeus (cl), which is separated along its anterior border from the labrum (lbr) by the clypeo-labral suture (cls). The lateral ocular lobes (ol) are separated from the clypeus laterally by the clypeo-frontal suture (cfs) and extend around the sides of the head to the premaxillary sutures (pms), forming the lateral sides of the head capsule. The plate occupying the center of the ventral side of the capsule, the maxillary segment (mxs), exhibits no indication whatever of a median suture. This segment is separated from the ocular lobes on either side by the premaxillary sutures, each of which is external evidence of an internal chitinous ridge and is terminated at its postero-lateral corner in ***Melanoconion*** by the posterior tentorial pit (ptp) at the site of an internally directed apodeme, the posterior tentorial arm (pta, fig. 4). In all species of ***Melanoconion*** so far examined, the premaxillary suture extends to the ventro-lateral margin of the occipital foramen (of). The anterior margin of the maxillary segment, bounded laterally by the premaxillary sutures, forms the posterior ventral margin of the mouth opening (mo), and the anterior ventral edges of the ocular lobes form its lateral boundaries. The ventral mouth opening thus occupies the anterior ventral half of the head. The ocular lobes extend to the posterior margin of the head where they form a rather heavily sclerotized collar surrounding the occipital foramen.

Near the anterior end of the premaxillary suture is an internally directed process (figs. 4 and 5) which supports the mentum (mt), a characteristically shaped, heavily pigmented structure, usually with a strong central and five to seven smaller, anteriorly directed teeth. It is arched over the anterior end of the maxillary segment, and between

the former and the latter lies the auleum (au), a narrow, extremely transparent transverse plate with long, transparent, anteriorly directed hairs which are usually invisible in the ordinary mount. Dorsad of the mentum lies the prementum (prm), a structure difficult to distinguish with ordinary mounting procedures, and composed of a series of anteriorly directed teeth and spines. The author has investigated the value of this character for identification and finds that it appears to be rather constant within a given species, although its inaccessible position makes it an unsatisfactory source of taxonomic characters. The prementum is firmly attached to the dorsal (*i.e.*, internal) surface of the mentum and laterally is constricted into a narrow cibarial bar (cb, figs. 4 and 5) which extends transversely across the head to a point of attachment near the base of the antenna. Just mesad of this point of attachment, a slender bar called the anterior tentorial arm (ata) extends diagonally to the innermost end of the posterior tentorial arm. Anterior to the cibarial bar is a series of small chitinized plates (fig. 3) which operate together to promote the action of the mouthbrushes. These are the lateral palatal plate (lpp), messor (mes), messorial apodeme (mesa), palatal bar (pb) and the palatal brush (pbr). These parts change position on ecdysis and observations indicate little variation from species to species. Therefore, they are not described here in detail. The maxillae and mandibles, however, do bear characters of possible value for identification and are described below.

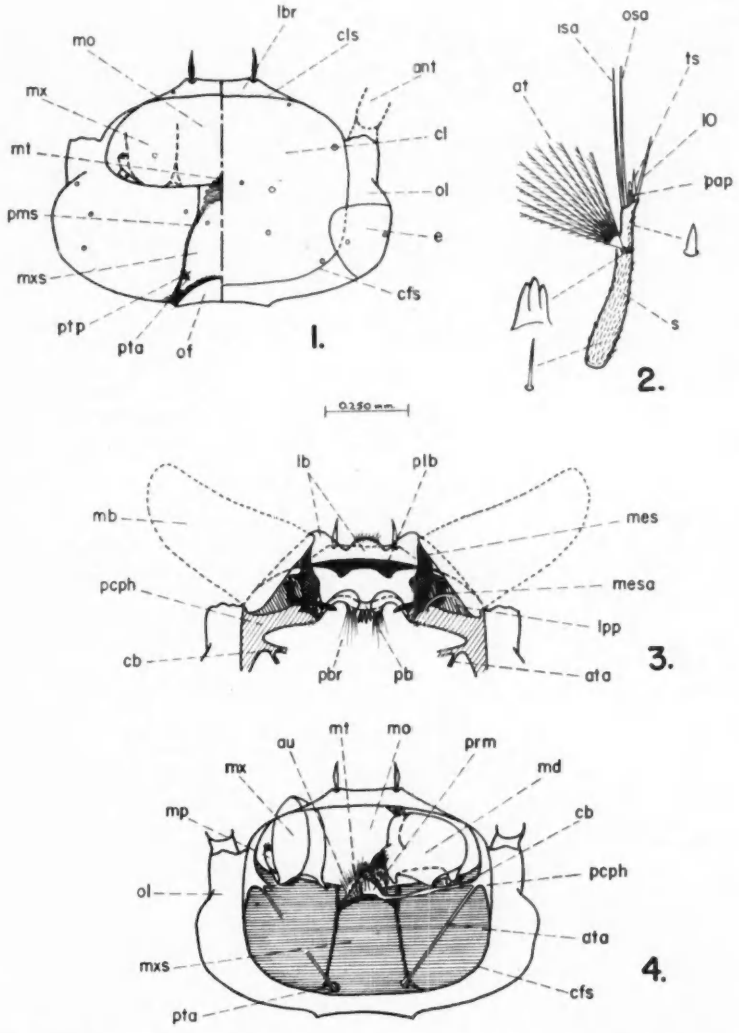
The center of the cibarial bar is darkened and slightly thickened and forms the dorsal articulation of the mandible (md, fig. 4). The ventral articulation of the mandible is a short, stout apodeme at the anterior edge of the ocular lobe below its dorsal attachment, so that the mandible moves in a direction parallel to the horizontal plane of the head. The mandible (fig. 7) is an elongated structure with a row of long bent hairs and two or three long heavy curved spines around the anterior oral crest. Posterior to this row of hairs on the oral surface are the mandibular teeth (mant) and below these the dorsal articulation. There are several series of long hairs intervening between these as shown. Examination of the mandibular teeth of several species, one of which is represented by specimens from several localities, indicates them to be quite constant characters. There are two sets of mandibular teeth, one lying directly over the other. The ventral set (vs, fig. 7) consists of a fairly long, slightly curved ventral spine (vsp, figs. 8, 11 and 12), an anterior ventral tooth (avt) and a posterior ventral tooth (pvt), the latter divided into two secondary teeth, either equal in size or the anterior smaller than the posterior. Between the anterior and the posterior ventral teeth there are usually two long, fairly heavy projections which vary in shape from species to species. In some they are slender spines, with or without clubbed ends, in others they are of varying shapes and sizes, and in yet others one of the spines is modified into a heavy projection of an entirely different shape. The dorsal set (ds) consists of two simple teeth, one anterior (adt, figs. 9 and 10) and one posterior (pdt). Immediately posterior to the posterior dorsal tooth lies a group of three or four heavy rather transparent accessory spines or teeth (act). Ventrad of these two sets of

teeth are two long transparent arms (ta, figs. 7 and 13), the posterior one-half to two-thirds the length of the anterior. Their bases nearly overlap when viewed from above or below, and their tips extend well past the oral edge of the mandible into the oral cavity. The mandibles are articulated to move in the horizontal plane of the head and the heavily sclerotized mandibular teeth are directed posteriorly and impinge on the anteriorly directed teeth of the prementum to form a grinding surface.

The maxillae (fig. 6) are situated just above the mandibles and, to the uninitiated, the two are difficult to separate until the relative shapes and positions of the two are learned. The maxilla is more or less elongated in an anterior-to-posterior direction while the mandible is relatively long in a transverse direction. The maxilla is composed of three distinct parts: the stipe (st) forming the main body, the palpifer (pf) which is partially fused to the ventral anterior margin of the anterior lobe, and the reduced palpus (pal). The stipe bears at its tip a row of long, slightly bent hairs and on the ventral oral surface a fairly heavy maxillary spine (mxsp), sometimes darkly pigmented and comparable in size to the preclypeal spines. This spine in at least one of the species studied, ***mulrennani***, appears to be considerably larger and heavier than the preclypeal, and promises to have some

LIST OF ABBREVIATIONS

ac—acus
act—accessory teeth
adt—anterior dorsal tooth
ant—antenna
asp—apical spine
aspg—anterior submedian prothoracic group
at—antennal tuft
ata—anterior tentorial arm
au—aulaeum
avt—anterior ventral tooth
c—comb
cb—cibarial bar
cfs—clypeo-frontal suture
cl—clypeus
cls—clypeo-labral suture
ds—dorsal set of mandibular teeth
e—eye
g—gills
ihdt—inner hair of dorsal tuft
isa—inner subapical spine
lbr—labrum
lh—lateral hairs
lpp—lateral palatal plate
lt—lateral tuft
mant—mandibular teeth
mb—mouth brush
md—mandible
mes—messor
mesa—messorial apodeme
mespg—mesothoracic pleural group
metpg—metathoracic pleural group
mo—mouth opening
mt—mentum
mx—maxilla
mxs—maxillary segment
mxsp—maxillary spine
of—occipital foramen
ohdt—outer hair of dorsal tuft
ol—ocular lobe
osa—outer subapical spine
p—pecten
pal—maxillary palpus
pap—papilla
pb—palatal bar
pbr—palatal brush
pcph—paraclypeal phragma
pdt—posterior dorsal tooth
pf—palpifer
plb—posterior ventral margin of labrum
pms—premaxillary suture
ppg—prothoracic pleural group
prm—prementum
pta—posterior tentorial arm
ptp—posterior tentorial pit
pvt—posterior ventral tooth
s—shaft of antenna
sh—saddle hair
st—stipe
ta—transparent arms
ts—terminal spine
vb—ventral brush
vs—ventral set of mandibular teeth
vsp—ventral spine
vt—ventral tuft



Details of morphology of head of *Culex* (*Melanoconion*) *atratus* Theobald.

FIG. 1. Dorsal (right) and ventral (left) exterior view. FIG. 2. Dorsal view of right antenna with details of chaetotaxy. FIG. 3. Dorsal view of head with clypeus removed, showing relative positions of movable plates forming the anterior mouth parts. FIG. 4. Dorsal view of head with clypeus removed, showing the relative positions of internal structures.

taxonomic value. The palpus is situated at the lateral margin of the stipe at its base. It is terminated by four small spines which are difficult to see in ordinary slide mounts. The palpifer bears a single, small hair in all the species examined (Hair No. 17—see below). With the exception of the maxillary spine, the maxilla is too lightly sclerotized to present taxonomic characters of importance, and appears to vary but little in form from species to species in this group.

The anterior portion of the ocular lobe is produced laterally to form a shoulder which bears the antenna (fig. 2). The antenna in this group of mosquitoes is usually about one and one-half times the length of the head, or slightly less, not including the apical spines. The basal two-thirds of the shaft (s) is always curved inwards, especially along its lateral margin. Situated on its inner dorsal surface about two-thirds of the distance from the base to the tip is a constriction which continues to the insertion of the subapical spines (isa, osa). A further slight constriction at the site of insertion of these spines continues to the end of the antenna. The antennal shaft is usually rather heavily spined, especially on its outer dorsal and ventral surface, and in some species is infuscated for some distance along its length.

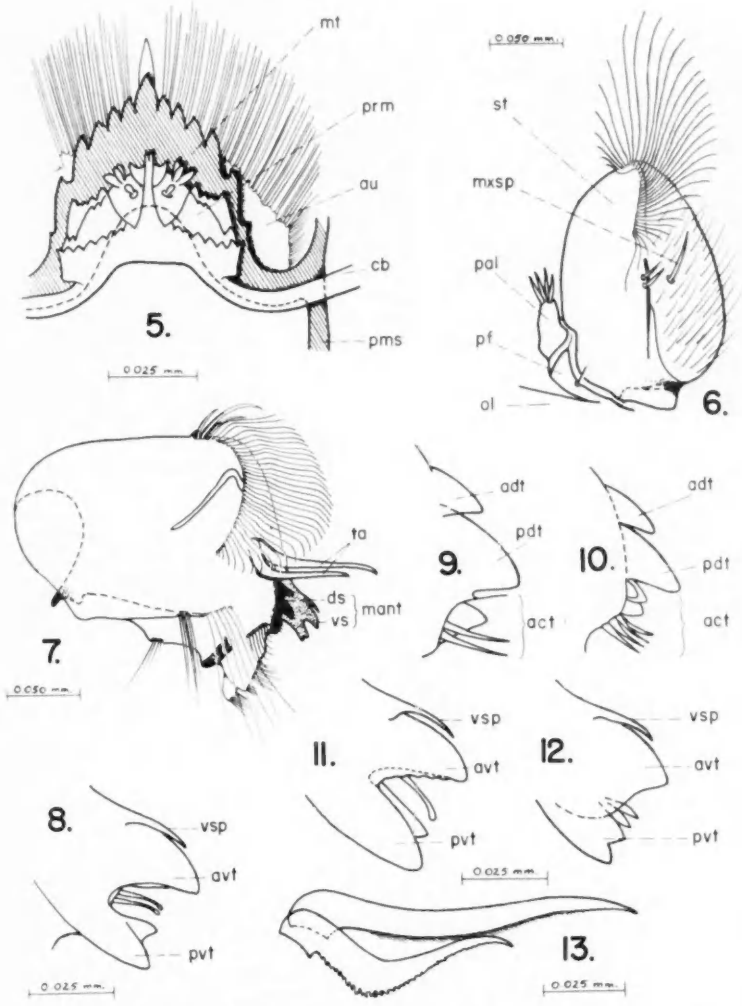
Thorax

The thorax (fig. 24) of all species examined is about the same size as the head, broadly oval in outline, wider than long, its proportions in general are approximately 4 to 3. The boundaries between the pro-, meso- and metathorax are indistinct, but each segment may be identified by the position of the large lateral hairs, the ventro-lateral pleural hair groups and the fine hairs occurring on the dorsal and ventral surfaces. The surface of the thorax in all specimens seen by the author is covered by a "pile" of spicules of varying density.

Abdomen

The abdomen (Plates III and V), as in all culicine larvae, is composed of ten true segments. The first two are approximately twice as wide as long, and are wider than any of the following segments by virtue of a prominent lateral swelling which supports the large lateral hair or hairs. Proceeding posteriorly, the following five segments become gradually narrower so that, in general, the sixth and seventh abdominal segments are about five of length to nine of width. The lateral swelling so prominent in Segments I and II is much reduced in Segments III through VI and completely absent in Segment VII. The size of this prominence appears to be directly proportional to the size of the lateral hair it supports. It is well to bear in mind that Segment VII is usually removed with the segments posterior to it in ordinary slide mounts, consequently its chaetotaxy must be given special consideration (fig. 27).

I have called the last (anal) segments of the abdomen Segment X and the next-to-the-last segment Segment VIII-IX, the latter representing, in reality, a fusion of the two. This is not in accord with the conventions already extant in culicine literature in which the compound segment is called Segment VIII and the anal segment Segment IX.



Details of mouthparts of *Culex* (*Melanoconion*) spp.

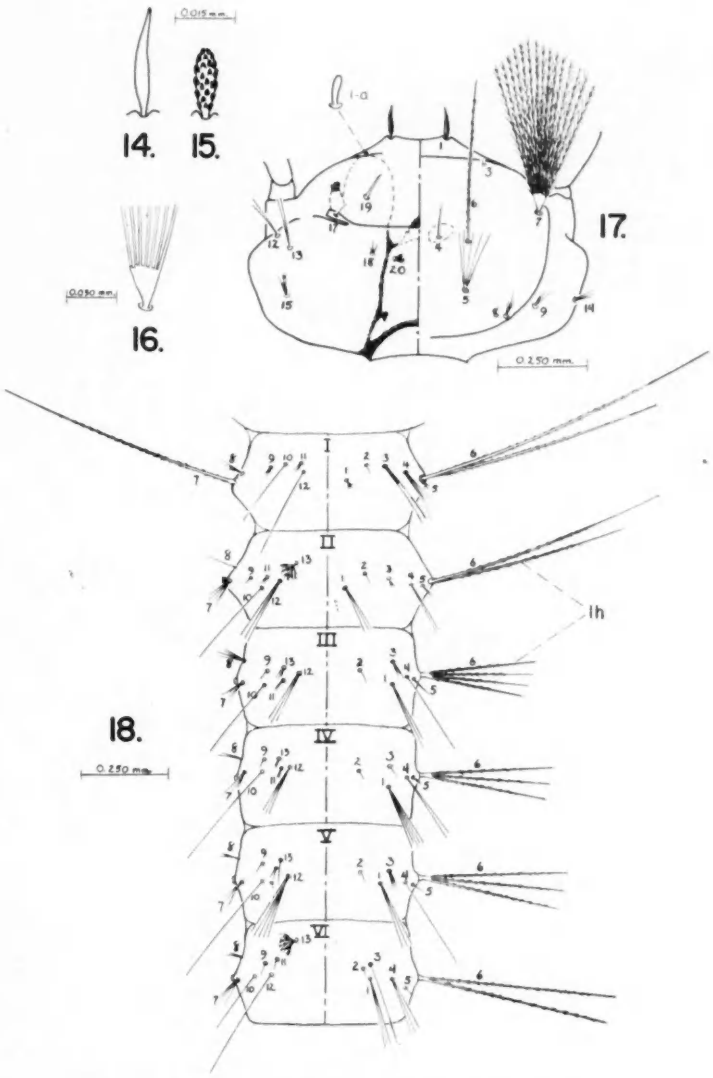
FIG. 5. *C.* (*M.*) *atratus* Theobald: dorsal view of mentum, prementum and auleum. FIG. 6. Same, ventral view of right maxilla. FIG. 7. Same, ventral view of right mandible. FIG. 8. Same, ventral view of ventral teeth of right mandible. FIG. 9. *C.* (*M.*) *peccator* D. & K.: ventral view of dorsal teeth of right mandible. FIG. 10. *C.* (*M.*) *atratus:* ventral view of dorsal teeth of right mandible. FIG. 11. *C.* (*M.*) *pilosus* D. & K.: ventral view of ventral teeth of right mandible. FIG. 12. *C.* (*M.*) *erraticus* D. & K.: ventral view of ventral teeth of right mandible. FIG. 13. *C.* (*M.*) *atratus:* transparent arms of right mandible. (See page 451 for key to abbrevietions).

The posterior margin of Segment VIII-IX (fig. 27) is roughly triangular in shape so that the air tube projects dorsally on one diagonal surface of the triangle and the anal segment projects from the other surface at approximately 90 degrees ventral to it.

The air tube is a strongly sclerotized structure whose proportions of width at base to length varies from 1 to 3 to 1 to 10, the largest number of species with these proportions lying somewhere between 1 to 5 and 1 to 7. In almost all species a rounded, sclerotized ridge completely surrounds the extreme base of the air tube except in a narrow area on each side just below the lateral line, where there occurs a forward-projecting tooth of sclerotization called the acus (ac). This is present in all species of the genus, and appears to vary considerably within each species. However, the dorsally projecting extension of the acus is absent in all members of the Section *Mochlostyrax*. The posterior end of the air tube is provided with a system of valves common to most culicines. No indications have been found that the valvular apparatus is of any diagnostic value in this group. It is difficult to study in ordinary slide mounts. The air tube is often slightly curved and is always one and one-half to two times as broad at its base as at its tip. In the Section *Mochlostyrax* the air tube is distinctly rounded along its ventral margin and bears ventral tufts to its extreme tip (fig. 44).

Abdominal segment X (anal segment) is considerably smaller in diameter than the preceding ones. It is completely surrounded by a ring of sclerotization which extends from the posterior dorsal margin of the segment to a point near its attachment with Segment VIII-IX. On the ventral side of the tenth segment the posterior edge of this ring passes anterior to the first pair of hairs of the ventral tuft. The anterior margin of the ring passes around the segment in nearly a straight line. Thus, the ventral side of the ring is shorter than the dorsal side. The segment is usually about the same width throughout, but sometimes appears to be distinctly broader at its apex than at its base. The plate itself is provided in every species with some degree of spinulation (fig. 39) which, in some species, is confined to the extreme apex of the plate, where it may lengthen into a patch of distinct spines, and in others is distributed evenly over the entire plate in the form of rows of extremely minute spicules, or it may take the form of a combination of the two types. There appears to be little variation in the picture of this spinulation from species to species, and appears to be of distinct value in species identification.

The anal gills (g, fig. 27) are always four in number and are attached to the posterior portion of the anal segment. They are transparent and vary in length from one to three times the length of the anal segment. There have been no outstanding characters found in the anal gills to justify their use as taxonomic characters, at least in the material available to me. It has not been possible to investigate the characters of these organs in their relation to the character of their water habitat. They have been found to be missing or shrivelled in many of the slide mounts available for this study.



Head and abdomen of *Culex* (*Melanoconion*) spp., showing details of chaetotaxy.

FIG. 14. Preclypeal spine of *C.* (*M.*) *atratus*. FIG. 15. Preclypeal spine of *C.* (*M.*) *sursumptor* Dyar. FIG. 16. Base of Hair 13 (anterior infra-orbital) of *C.* (*M.*) *pilosus*. FIG. 17. Dorsal (right) and ventral (left) view of head of *C.* (*M.*) *atratus*. FIG. 18. Dorsal (right) and ventral (left) view of abdominal segments I through VI of *C.* (*M.*) *atratus*. (See page 451 for key to abbreviations.)

CHAETOTAXY

An effort has been made to record the following information for each hair:

1. Name and number of hair. Names appearing in parentheses are ones which have been given to hairs of anophelines and culicines by previous workers. Many of the names appearing in italics (the author's) are arbitrary designations, but are offered in the hope that future work along these lines may be carried on without duplication and confusion.
2. The position of the hair on the body in text and by illustrations.
3. Number of branches.
4. Relative length.
5. Any special characteristics, such as presence or absence of spinules, type of base, etc.
6. An estimate of its value in classification. In some cases it has been possible to note the variation existing, not only among the various species of the group, but among specimens of a single species and how it holds as a character for ***Melanoconion*** in contrast to other closely related subgenera.

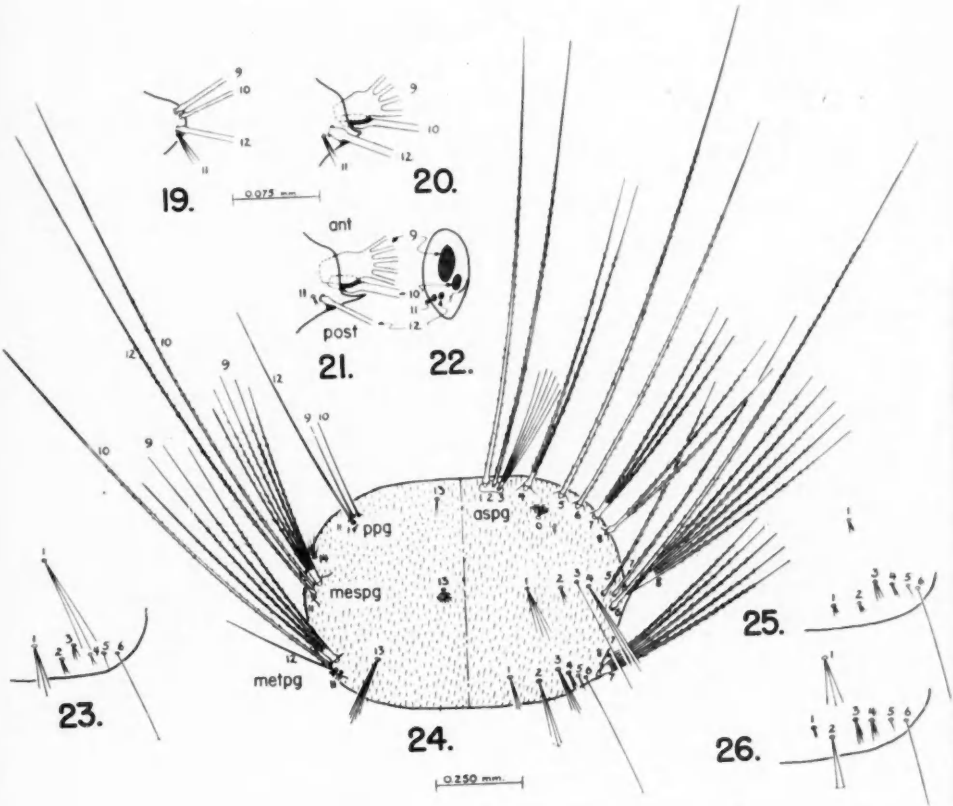
In this chaetotactic study, an attempt has been made to homologize the hairs of ***Melanoconion*** with those already named and described for *Anopheles*. In view of the fact that this kind of homology does exist to a marked degree in certain body regions, this procedure of giving hairs the same designations in both groups appears to be justified in many cases. In situations where no such apparent homology is evident, or where the homologies are uncertain, arbitrary designations have been assigned. The study has involved the examination of different numbers of species for each region of the body. Approximately 227 specimens distributed among 32 species have been examined for the chaetotaxy of the head, all of the dorsal prothoracic hairs, the lateral hairs on abdominal segments I through VI, the air tube tufts and the characters of the dorsal tuft of the anal segment. All other characters are based on the study of the following eleven species: ***atratus, chrysonotum, conspirator, dunni, educator, elevator, erraticus, iolambdis, lucifugus, mistura, pilosus.***

It has been my experience that the length of the delicate hairs, especially those of the ventral surfaces, are often difficult to measure, especially in older or in poorly prepared mounts. For this reason, the branching of a hair, in general, is taken to be of much greater diagnostic value than its length. Where the length of the branches of any one hair show appreciable differences, the longest of these is taken as the tuft length.

Head

(Fig. 17)

1. ***Preclypeal spine*** (preclypeal hair, clypeal spine, inner preclypeal, preclypeal bristle). Always inserted in a narrow shallow depression at the extreme anterior edge of the preclypeus, usually about halfway between its centerline and its lateral termination, and always darkly pigmented, tending to lie at various angles in slide mounted



Chaetotaxy and morphology of thorax of *Culex* (*Melanoconion*) spp.

FIG. 19. *C.* (*M.*) *atratus:* dorsal view of prothoracic pleural tubercle, showing insertion of Hairs 9 through 12. FIG. 20. Same, dorsal view of mesothoracic pleural tubercle, showing insertions of Hairs 9 through 12. FIG. 21. Same, dorsal view of metathoracic pleural tubercle showing insertions of Hairs 9 through 12. FIG. 22. Same, lateral view of metathoracic pleural tubercle. FIG. 23. Relative lengths and positions of mesothoracic Hair 1 and metathoracic Hairs 1 through 6 of *C.* (*M.*) *educator* D. & K. FIG. 24. Dorsal (right) and ventral (left) views of thorax of *C.* (*M.*) *atratus*. FIG. 25. Relative lengths and positions of mesothoracic Hair 1 and metathoracic Hairs 1 through 6 of *C.* (*M.*) *pilosus*. FIG. 26. Relative lengths and positions of mesothoracic Hair 1 and metathoracic Hairs 1 through 6 of *C.* (*M.*) *lucifugus* Komp. (See page 451 for key to abbreviations.)

specimens so that its true length is difficult to determine. In all but one species this spine is smooth, sharply pointed, and of the same proportions as in fig. 14, its greatest width at the basal fourth or third. In one species, ***sursumptor***, this spine is distinctly denticulate and blunt at the tip (fig. 15).

1a. ***Outer preclypeal spine***. A minute, transparent, blunt spine on the ventral side of the preclypeus near its lateral termination, present in all species. In most slide mounts its socket may easily be mistaken for the insertion of one of the underlying mouthbrush hairs.

2. ***Inner anterior clypeal hair*** (inner clypeal, anterior clypeal). See discussion of Hair 3 below.

3. ***Outer anterior clypeal hair*** (outer clypeal, anterior clypeal). A minute examination of the head capsule reveals the complete absence of Hairs 2 and 3 in all but one species, ***aikenii***, the only representative of the Section ***Gnophodeomyia***. In this species only one of the two hairs is present as a short slender spine at the extreme anterior edge of the clypeus directly behind Hair 1a. Since its homology with anophelines is impossible to establish, and because its distance from the centerline is relatively great, it is arbitrarily designated as Hair 3, Hair 2 being considered as absent.

4. ***Posterior clypeal hair*** (preantennal, anterior frontal). Always anterior to Hairs 5 and 6, but may be anterior or posterior to Hair 7. Although its point of insertion may be found within the limits designated by the dotted circle around its base shown in fig. 17, its position appears to be constant for each species. Always an extremely fine hair, either single or double, rarely triple, occasionally branched beyond the middle.

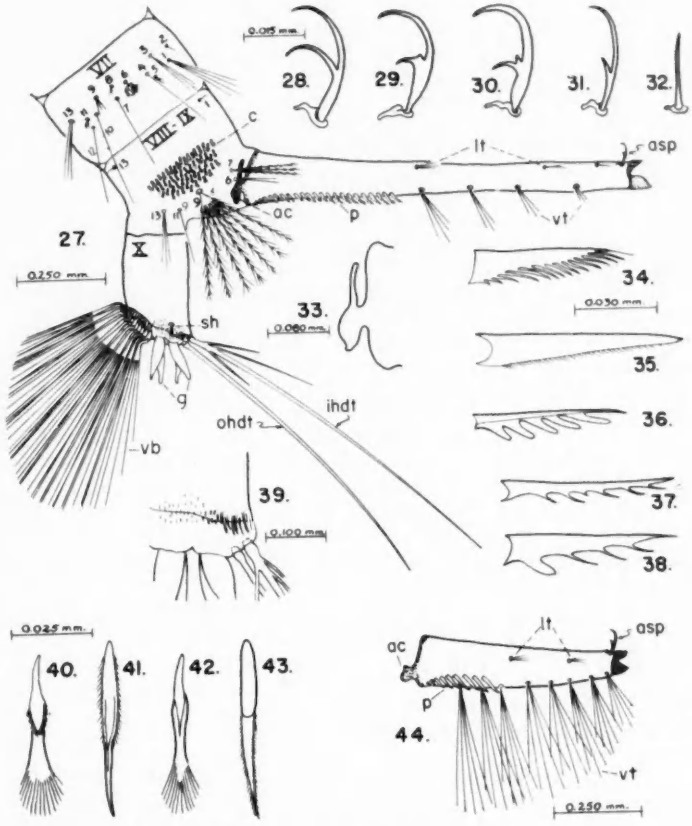
5. ***Upper head hair*** (frontal, inner post-antennal, Hair C, inner frontal, median frontal). Always inserted near the basal third of the head, posterior to and closer to the center line than Hair 6. One-fourth to two-thirds the length of Hair 6, but exhibits considerable variation in branching, and with few exceptions I consider it to be a rather unreliable character for the separation of species.

6. ***Lower head hair*** (frontal, mid post-antennal, Hair B, mid-frontal, submedian frontal). This hair has proved to be single in every larva examined for this study. Situated at the middle of the head, about one-third the distance from the center-line to the lateral margin, it nearly always exceeds the anterior margin of the head capsule and is commonly provided with lateral spinules.

7. ***Pre-antennal hair*** (frontal, outer post-antennal, lateral frontal, ante-antennal, pre-antennal, outer frontal, Hair A). Always at the base of the antenna posterior to and inside the lateral frontal margin of the clypeo-frontal suture. An extremely heavy hair with a flat triangular base with from five to seven branches (Section ***Mochlostyrax***) to as many as 14 in the other species. Its longest branch attains the basal two-thirds of the sub-apical antennal hairs. The reduction in branching appears to be characteristic of the members of the section ***Mochlostyrax***.

8. ***Inner clypeo-frontal*** (vertical, inner occipital, sutural, Hair e). A relatively short, fine multiple hair just inside the clypeo-frontal suture at the posterior margin of the eye, and difficult to see in whole mounts.

9. ***Outer clypeo-frontal hair*** (trans-sutural, outer occipital, vertical,



Details of morphology and chaetotaxy of terminal abdominal segments of *Culex* spp.

FIG. 27. Abdominal segments VII to X of *C. (M.) atratus*. FIGS. 28–32.: 28, apical spines: *C. (M.) batesi* R. & K.; *C. (M.) caudelli* (D. & K.); 30, *C. (M.) pilosus;* 31, *C. (M.) atratus;* 32, *C. (Neoculex) apicalis* Adams. FIG. 33. Acus of *C. (M.) atratus*. FIGS. 34–38. Pecten spines: 34, *C. (M.) atratus;* 35, *C. (M.) mistura* Rozeboom; 36, *C. (M.) plectoporpe* Root; 37, *C. (M.) sursumptor* Dyar; 38, *C. (N.) apicalis* Adams. FIG. 39. Details of armature of anal segment of *Culex (M.) atratus*. FIGS. 40–43. Comb scales: 40, *C. (M.) atratus;* 41, *C. (M.) pilosus;* 42, *C. (M.) aikenii* (Aiken) (from anterior row); 43, *C. (M.) aikenii* (Aiken) (from posterior row). FIG. 44. Air tube of *C. (M.) pilosus* D. & K.

(See page 451 for key to abbreviations.)

Hair f). Always situated at the outer side of the clypeo-frontal suture at about the middle of the eye and anterior to Hair 8, always multiple. Hairs 8 and 9 are usually approximately the same size, although in two species Hair 9 is considerably longer. The taxonomic value of this relationship is considered doubtful since these hairs are difficult to see in whole mounts.

10. ***Terminal spine*** (terminal antennal hair, terminal hair) (ts, fig. 2). In accord with usage in *Anopheles*, this hair is here given the same number. It is a fairly strong, smooth, pointed, single spine always situated at the extreme outer tip of the antenna and in all cases as long or longer than the constricted part of the antenna.

Subapical spines (isa, osa). Inserted on the inside lateral margin of the antenna at a point of very slight constriction, one dorsal and one immediately ventral and slightly distad to it. These are apparently homologous with the sabre-like spines of *Anopheles*. They are nearly the same length, always single, one and one-half to two times as long as Hair 10.

Apical spine. A smooth sharp straight spine inserted at the extreme tip of the antenna immediately ventral to the insertion of Hair 10, and always shorter than the latter.

Papilla (pap). A short stout structure of indeterminate length which is chitinized only on its basal half and inserted very close to the bases of the apical and terminal spines.

11. ***Antennal tuft*** (at) (antennal hair, shaft hair). Naming and numbering of this hair is also in accord with anopheline procedure. Always situated on the shoulder which initiates the constriction of the antenna at the outer third of the latter, its point of insertion partially covered by a small, 2 to 4 pointed lamellate spine. An extremely heavy tuft whose size and form approaches that of Hair 7. It also has a triangular base; its numerous branches, sometimes exceeding 30 in number, are spiculate only on the posterior side of each branch and, as in Hair 7, the exact number of branches commonly difficult to count. This hair is too constant in size and form to be of taxonomic value in this subgenus.

12. ***Sub-antennal hair*** (basal). Situated on the ventral side of the ocular lobe directly posterior to the base of the antenna on a slight fold of the capsule, often very fine and difficult to see, multiple as often as single and of varying lengths, these characters appearing to be fairly species specific.

13. ***Anterior infra-orbital hair***. A fine hair on the ventral side of the ocular lobe posterior to and inside the insertion of Hair 12 at about the middle of the eye. In Section ***Mochlostyrax*** it exhibits from seven to 14 branches (fig. 16), far more than in any other species, and nearly always exceeds the insertion of Hair 12.

14. ***Orbital hair*** (supra-orbital, ocular). A fine hair always on the lateral margin of the ocular lobe anterior to the eye. It is usually a fine hair comparable in size to Hairs 8 and 9, always multiple, and apparently with little diagnostic value, its branchings often being obscure.

15. ***Posterior infra-orbital*** (infra-orbital). A fine hair always posterior to and slightly inside the insertion of Hair 13, multiple and of

varying lengths. The taxonomic value of this hair has not been determined because, along with Hair 13, it is nearly impossible to see in ordinary whole mounts.

16. ***Palpal hair.*** In all *Melanoconion* studied to date a distinct hair on the maxillary palp is completely absent.

17. ***Basal maxillary hair.*** A minute, single, rather transparent spine-like hair situated at the extreme base of the ventral sclerite of the maxilla. The taxonomic potentialities of this hair have not been evaluated, since it is relatively only easily studied in head capsules which have been well cleared or which have been mounted ventral side up.

18. ***Outer pre-maxillary hair*** (post-maxillary). A minute hair always situated on the outside of the premaxillary suture near the attachment of the mentum, the number of branches difficult to determine through the head of most whole-mounted specimens, but rarely single. In two species it is relatively long, equivalent in length to Hair 12. Its branches are always stiff and well spread out as shown.

19. ***Maxillary spine.*** Situated on the ventral, oral side of the maxilla, usually comparable in size and shape to the preclypeal spine but of varying degrees of transparency. Dodge (1945) states that the shape and position of this spine as shown characterize three North American *Melanoconion* larvae in all instars. Its characteristic position holds for all of the 32 species examined for this study, all other species of the genus *Culex* having this spine lateral and apical in position and much smaller.

20. ***Inner pre-maxillary hair*** (sub-mental). A minute hair whose multiple branchings are difficult to make out through uncleared heads. It is comparable in size to Hair 18, and when both are observed together, their characters may prove to have diagnostic value.

Thorax

(Plate IV)

Prothorax

0. ***Accessory dorsal hair.*** In all species of *Melanoconion* larvae this hair lies on the dorsal surface of the prothorax posterior to the space between Hairs 4 and 5 (see below) and opposite Hair 8. It is characteristically short, never attaining the anterior margin of the prothorax, and has from 10 to 20 or more branches. It is fan-shaped, with a short, triangular base.

1, 2 & 3. ***Anterior submedian prothoracic hair group*** (aspg, fig. 24). These hairs arise from a lightly chitinized plate of irregular shape and occur just distad of the centerline on the dorsal anterior margin of the prothorax. 1. ***Inner hair.*** The strongest of these three hairs, it is always the posterior-most and closer to the center than the other two. It is one of the heaviest hairs of the entire body, and laterally spiculate. 2. ***Middle hair.*** Situated immediately anterior to and just outside Hair 1, its length and diameter are approximately one-half to three-fourths that of the latter. It is also spiculate. 3. ***Outer hair.*** Lies immediately anterior and distal to Hair 2. It is never more than

two-thirds the length of Hair 2 and is two to 11 branched in all members of the subgenus, the individual branches usually relatively fine, arising from a short stem, and usually of unequal length. The remainder of the anterior prothoracic hairs are ranged about the dorsal anterior edge of the segment to the lateral margin, and are all directed anteriorly.

4. *Dorsal hair*. A heavy, laterally spiculated hair, slightly shorter than Hair 2. In one species, *aikenii*, its branches vary from two to four; in all other species studied, it is either single or double.

5. *Dorsal hair*. Always separated from Hair 4 by a distance greater than that between Hairs 3 and 4. It is the longest and heaviest of the prothoracic hairs, always single and spiculated.

6. *Dorsal hair*. Situated distad of Hair 5 and very close to it, slightly shorter and always spiculated.

7. *Inner dorso-lateral hair*. About half as long as Hair 6, always spiculate, at least two-branched, often three and rarely four.

8. *Outer dorso-lateral hair*. Posterior to Hair 7, rarely single, often with two or three branches and extremely rarely with four. About the same length as Hair 7 and spiculate.

Senevet and Abonnenc (1939) have proposed a formula for designating these anterior dorsal hairs of the prothorax, (I-a-b)-c-I-I-d-e. The first three letters in parentheses represent the number of branches of the hairs in the anterior submedian prothoracic hair group. Each of the others from left to right represent Hairs 4 through 8, respectively. The I's in this formula represent the hairs which they found to be always single in their study of the genus *Culex*. In their discussion of each species, numbers are substituted for the letters representing the respective numbers of branches of each hair. In all species of the subgenus *Melanoconion* so far studied, Hairs 1, 2, 5 and 6 are always single. In constructing a key to the species available to me I found that this set of characters may be used to separate large groups of species, since about half of the 32 species so far examined have Hair 4 branched, and half single. It is felt that the branching and length of Hair 3 and the branching of Hairs 4, 7 and 8 may be of some diagnostic value.

9, 10, 11 & 12. *Prothoracic pleural group* (ppg). This is situated on the ventral side of the prothorax near the lateral margin, the four single hairs mounted on a distinct tubercle which exhibits no special chitinization (fig. 19). 9. *Anterior dorsal hair*. A short, single seta. 10. *Anterior ventral hair*. Lies beneath and slightly posterior to Hair 9, and is usually the same length as the latter. In one species, *batesi*, this hair is double. 11. *Posterior ventral hair*. This hair is extremely minute and always branched. It should be noted here that Hair 11 of the prothoracic pleural group has assumed a ventral position, while on the other two segments of the thorax it is dorsal and is termed the *posterior dorsal hair*. 12. *Posterior dorsal hair*. The longest hair of the group, always single.

13. *Ventral submedian hair*. The closest of all the prothoracic hairs to the midline, it is single or double and nearly always attains the anterior margin of the prothorax.

14. *Ventral lateral hair*. Apparently present in all *Anopheles* but entirely absent in all of the *Melanoconion* studied to date.

Mesothorax

1. *Dorsal hair.* Always multiple, usually four to six times as long as prothoracic hair 0. Of the 11 species examined in minute detail, Hair 1 is midway between the anterior and posterior margin of the segment, and about one-third the distance from the centerline to the lateral margin. Dodge (1945) states that in the first, second and third instar larvae of *Culex nigripalpus* and *C. salinarius* this hair is of positive value in identification. Figs. 23, 25 and 26 show the variations in length of this hair in *educator*, *pilosus* and *lucifugus*, respectively.

2. *Dorsal hair.* Separated further from Hair 1 than from Hair 3, in line with Hairs 1 through 4, about the same length as prothoracic Hair 0 and nearly always two to four branched.

3. *Dorsal hair.* Usually slightly anterior to Hair 2, but nearly in line with Hairs 1 through 4. In all species a long, fine, single hair, sometimes but not always longer than Hair 1, usually exceeding the lateral margin of the thorax.

4. *Dorsal hair.* Multiple in all species and usually about half the length of Hair 3. Hairs 2, 3 and 4 always about the same distance apart and slightly set apart as a group from Hair 1.

5. *Dorsal hair.* A single, long, laterally spiculate hair situated laterad of Hair 4.

6. *Dorso-lateral hair.* Immediately posterior to and sometimes only slightly laterad of Hair 6, long, single, spiculate, about the same size as Hairs 5 and 7.

7. *Dorso-lateral hair.* Large, single, inserted anterior to and laterad of Hair 6, which it resembles in size and spiculation.

8. *Lateral hair.* Always on the lateral margin at the widest part of the thorax, inserted in a more or less fleshy lateral tubercle. One of the most massive of the thoracic hairs, extremely heavily chitinized, with from four to nine branches, each branch with lateral spicules.

9, 10, 11 & 12. *Mesothoracic pleural group* (mespg, fig. 24). Four hairs growing from a lightly chitinized tubercle on the ventral side near the lateral margin. The tubercle bears a posterior spine against which the base of Hair 12 rests (fig. 20). 9. *Anterior dorsal hair.* About the same size and appearance as Hair 8, extremely large, heavily chitinized, spiculated. Hair 8 lies directly over Hair 9 so that the branching of each is sometimes made out with difficulty. This is the anterior and dorsal-most of the group. 10. *Anterior ventral hair.* Large, heavily chitinized, always single, provided with lateral spicules. 11. *Posterior dorsal hair.* Extremely minute, always posterior to and above base of Hair 12. 12. *Posterior ventral hair.* Always large and single, with lateral spicules, about the size of Hair 10. The hairs of the mesothoracic pleural group are arranged in the same manner as those of the prothorax, except that Hairs 11 and 12 have exchanged positions as discusssed above. Hair 9 is dorsal-most of the two anterior hairs 9 and 10, and Hairs 10 12 and 11 occur in that order from an anterior ventral to a posterior dorsal position.

13. *Ventral submedian hair.* Rather difficult to make out in most species because of its small size, but usually transparent and many-branched.

14. *Ventro-lateral hair*. Situated immediately anterior to the pleural group on the ventro-lateral margin, in most of the slide mounts it is in such a position that the number of branches are difficult to count. This hair is multiple, usually with 10 or more branches and is about the same size as prothoracic Hair 0.

Metathorax

1. *Dorsal hair*. Closest to center line, usually inside mesothoracic Hair 1. Two to five branched, varying in length from an extremely minute tuft (Section *Mochlostyrax*) to the attainment of the posterior margin of the metathorax.

2. *Dorsal hair*. Always with two to four branches and may be shorter or longer than Hair 1. Often is inserted posterior to the line made by the bases of Hairs 1 through 6.

3. *Dorsal hair*. With from three to five branches, rarely exceeding the posterior margin of the metathorax, shorter or longer than but always anterior to Hair 2, and on the same level or slightly anterior to Hair 1.

4. *Dorsal hair*. Slightly posterior to and laterad of Hair 3 in a line with Hairs 3 through 6, with two to four branches, always short. In none of the species examined does it exceed the posterior margin of the metathorax.

5. *Dorsal hair*. Laterad of Hair 4 and slightly posterior to it, in most cases a short single or double hair, about the same length as Hair 4.

6. *Dorso-lateral hair*. Always single, immediately laterad and slightly posterior to the base of Hair 5, eight to 10 times as long as the latter. Hairs 1 through 6 of *educator*, *pilosus* and *lucifugus* are shown in figs. 23, 25 and 26 to illustrate the variations encountered.

7. *Lateral hair*. Inserted on a prominent, lightly sclerotized tubercle on the lateral margin, provided with four to eight branches, each exhibiting small spicules, about the same length as Hair 8 of the mesothorax.

8. *Anterior lateral hair*. Immediately anterior to Hair 7 on the lateral margin of the metathorax, extremely fine, about the length of Hairs 4 and 5, always with at least six branches.

9, 10, 11 & 12. *Metathoracic pleural group* (metpg, fig. 24). Four hairs growing from a lightly sclerotized ventral tubercle on the ventro-lateral margin. A lateral posterior spine is present as in the mesothoracic group (figs. 21 and 22). 9. *Anterior dorsal hair*. The anterior, dorsal-most hair of the group, extremely heavily chitinized with four to eight branches, comparable in size to metathoracic Hair 7. Since Hair 7 lies directly over Hair 9, the branches of each are difficult to count. 10. *Anterior ventral hair*. Slightly posterior and ventral to Hair 9, longer than the latter and always single, with lateral spicules. 11. *Posterior dorsal hair*. Expremely minute in some species, this hair cannot be made out with any degree of certainty, but is always inserted at the extreme base of Hair 12. 12. *Posterior ventral hair*. Posterior and dorsal to Hair 10, about half the length of the latter, always single and spiculate. As in the mesothoracic pleural group, Hairs 10, 12 and 11 appear in that order from anterior to posterior so

that Hair 10 appears to be ventral-most, 12 subdorsal and 11 dorsal, Hair 9 being anterior to all three.

13. *Ventral submedian hair.* Inserted even with the metathoracic pleural group, slightly closer to it than to the ventral center line, with from four to eight branches, comparable in length to Hairs 1 and 2. Always a rather large hair, exceeding the lateral margin of the metathorax.

Abdomen

Segments I through VI

(Fig. 18)

There are typically 12 hairs on abdominal Segment I and 13 hairs on each of abdominal Segments II through VI. With few exceptions these hairs occupy characteristic positions on each segment, therefore I have found it more convenient and economical of space to discuss each hair in order, and to include in the discussion of each any deviations from whatever pattern may be evident in its form and position.

0. *Dorsal accessory hair.* Not present in the subgenus.

1. *Dorsal hair.* On the first and second segments of all species this is the hair closest to the centerline, inserted about halfway between the anterior and posterior margins of the segment. On Segment I this hair is relatively small and multiple (single in *dunni*), with from two to eight branches mounted on either an elongated or square transparent stem. On Segment II in most cases it is the same size and with the same branching characteristics as in Segment I, but in *atratus* it is long enough to exceed the posterior margin of the segment. On the remaining segments, however, this hair may be assumed to be homologous with the palmate of *Anopheles*. It is always situated posterior to Hair 3 (see below) or posterior to the space between Hairs 2 and 3, and is the most posterior of all the dorsal and lateral hairs. It is always long enough to exceed the posterior margin of the segment to the extent that not less than the apical third lies beyond the margin. It is always multiple, with at least three branches arising from a minute, transparent, triangular plate.

2. *Dorsal hair.* On abdominal Segments I through VI this is the anterior-most of all the small hairs on the dorsum. On Segments I and II it is the second in the line of fine dorsal hairs but on Segments III through VI is the closest to the centerline due to the position of Hair 1, and situated about midway between anterior and posterior margins. In all eight species it is a very small single hair, almost spinelike, with a relatively thick base (except in *erraticus*, in which it is double or multiple on Segments I and II). This hair is one of the most constant in form and position of all the abdominal hairs.

3. *Dorsal hair.* This is perhaps one of the most variable hairs of the abdomen. It is usually the third in the row of fine dorsal hairs, but on Segment I of *chrysonotum*, it appears to be moved posteriorly and toward the center from its normal position. The pattern of its alteration from one segment to the next is shown well by the illustration of *atratus* (fig. 18). The size and branching on Segments I and II occur with no regularity from species to species. They may be the

same size, or one smaller or larger or with fewer or more branches than the other in all combinations. In most species, however, this hair increases in length from Segment III through Segment VI, being relatively short and single, double or multiple on Segments III and IV, longer and with at least three branches on Segment V, and as long as or longer than Hair 1 on Segment VI, but always single or double on this segment. The only case in which it is distinctly shorter than Hair 1 on this segment is in *educator*. It is rarely with a stem of any kind on any of the segments.

4. *Dorsal hair*. One of the more constant of the dorsal hairs, it is always five to 10 branched on Segment I, usually about twice the length of Hair 2, rarely attaining the lateral margin of the segment. On Segments II through V, however, it is normally the longest of the fine dorsal hairs and single or double. On Segment VI it is nearly as long as Hairs 1 and 3, at least two branched, typically with three branches. In all segments it is anterior to and mesad of Hair 5, typically with an elongated, transparent stem.

5. *Dorso-lateral hair*. Invariably inserted nearly on a level with Hair 6 but distinctly mesad of that hair. It is commonly single but may have up to four branches on all of the segments, usually only slightly longer than Hair 2.

6. *Lateral hair*. On Segments I and II of all 32 species studied, this hair is two to three branched, rarely with four branches, spiculate, and about the same size as prothoracic Hairs 7 and 8. The anterior branch is always at least one-fourth longer than the posterior one or two, and on Segment II all branches are somewhat shorter than on Segment I. The species belonging to Section *Mochlostyrax* always have this hair three or four branched, and it occurs as a three branched hair in *mutator* as well, a species which does not belong in that section. On Segments III through VI this hair is about half the diameter of the preceding, always with at least two straight branches, spiculate or not. In at least half the species studied, the number of branches of this hair proved to vary to such an extent that it could not be used as a diagnostic character at all, while in several of the species, every specimen exhibited a two or three branched condition on every segment. In some species there appears to be a tendency for this hair to become longer on the posterior segments. On all segments this hair is strictly lateral in position, always mounted midway between the anterior and posterior margins on the lateral prominence mentioned above.

7. *Ventro-lateral hair*. On Segment I this hair is inserted on the lateral prominence directly below Hair 6. It is most commonly single (in Section *Mochlostyrax* it appears to be always three branched), spiculate in all species and longer than either of the branches of Hair 6. On Segments II through V, however, this hair is definitely ventro-lateral in position and with many branches. On Segment VI it is multiple and short as above in all species, except in *chrysonotum* and *erraticus*, in which it is single.

8. *Antero-lateral hair*. On the lateral margin directly anterior to the insertion of Hair 6. It is always a fine hair with one to four branches, commonly one to three branched on Segments III through VI. This hair reaches its maximum length on Segment II where it is

comparable in length to Hair 4 of that segment and single in all species but *pilosus*. Proceeding from Segments III through VI, it apparently becomes reduced in length.

9. *Ventral hair*. A minute, spine-like hair comparable in size and form to Hair 2. On all segments but the first it is definitely single, and inserted mesad of the space between the bases of Hairs 6 and 8. On Segment I it occasionally appears anterior to and mesad of Hair 8. Because of its size and position this hair is relatively easy to identify, though varies so little that it appears to be of little taxonomic value.

10. *Ventral hair*. In all eight species studied in detail this hair is inserted almost directly posterior to Hair 9 on Segments II through VI. Reference to fig. 18 will make its position clear. On Segment I it appears to be at least twice the length of Hair 9, and always multiple, except in *atratus*. The condition found in Segment I of that species is that found in all the following segments and on Segments II through VI of all the other species studied. This is perhaps the longest and finest hair of all those occurring on the abdomen. Its length is extremely difficult to measure because of its small diameter and the fact that in most slide mounts it has been caught in a tightly curved or wavy position.

11. *Ventral hair*. On Segment I this is the anterior-most of the small ventral hairs and nearly always about twice the length of Hair 9, but on the following segments it is nearly always inserted on a level with Hair 9 and mesad of it, and about the same length.

12. *Ventral hair*. On all segments, in general, this hair has the same position with respect to Hair 11 as Hair 10 to Hair 9. Reference to fig. 18 will make this relationship more easily understood. On Segment I this hair is generally inserted directly posterior to Hair 11, while on the following segments its location is closer to the center line. In all species except *pilosus* it is about half to three-fourths the length of Hair 10 (in the latter it is the same size as Hairs 9 and 11) and is single to three branched. The character of this hair appears to be variable from segment to segment.

13. *Ventral hair*. In all species the fine ventral hairs are difficult to homologize with those of *Anopheles*. Since only 12 hairs are present on Segment I, Hair 13 is arbitrarily assumed to be the missing one. It is the hair on Segments II through VI usually most anterior on the venter of the segment, absent on Segment I, present as a small, dendritic, many branched fan-shaped hair on Segment II, extremely small, single, double or triple on Segments III, IV and V, and again a small, dendritic, many branched fan-shaped tuft on Segment VI. This hair is extremely lightly pigmented and its exact number of branches extremely difficult to count through the abdomen in most mounts.

Segment VII

(Fig. 27)

In most slide preparations this segment is removed with the air tube and Segment VIII-IX from the remaining segments of the abdomen and laid in a lateral position. Very often this procedure has split the segment transversely across the line of hair insertions so that their relationships are impossible to determine. In specimens where such

distortions have been avoided, the homologies of these hairs with those of the preceding segments are quite clear. Because of this difficulty, the relative values for taxonomy of the hairs of this segment have not been determined. It is obvious, however, that the first hair on the air-tube side must correspond to Hair 1 of the preceding segment. The hairs appear, from the true dorsal to ventral side of the segment, in the following order:

2. Extremely short and single, as in segments III through VI.

1. Extremely long and multiple, posterior to and just inside Hair 2.

3. Fairly well developed and multiple, slightly anterior to Hair 2.

4. Long, single or multiple, same length as Hair 1, anterior to Hair 4 but posterior to Hair 3.

5. Extremely small, as in the preceding segments, distinctly posterior to Hairs 3 and 4.

6. *Lateral hair*. Extremely small, fan-shaped, about 10-branched.

7. About the same length as Hairs 1 and 4, single or double, usually directly posterior to Hair 8.

8. Extremely small, anterior to Hairs 6 and 7.

9. Multiple, slightly anterior to Hair 8 and about four times as long.

10. The longest hair of the segment, single or double, posterior to and laterad of Hair 9.

11. Extremely small, only about twice as long as Hair 8, inserted even with the base of Hair 10.

12. Posterior to and just inside Hair 11, about as long as Hair 4 and single or double.

13. A long multiple hair with at least three branches, somewhat shorter than Hair 1, the ventral-most of the hairs of this segment.

Segment VIII-IX

(Fig. 27)

1 & 13. In all species of *Melanoconion* two minute hairs occur near the anterior lateral margin of the segment. They have been artbirarily labelled Hairs 1 and 13 inasmuch as this designation represents the limits of the range of adbominal hairs on the preceding abdominal segments. Their homologies with those of *Anopheles* is not clear. Hair 1 is always found on the anterior lateral margin on the air tube side of the segment and Hair 13 in the corresponding position on the anal segment side. They are single hairs in all species studied, and are sometimes difficult to make out in those species with a dense long pilosity, but the two are invariably present and subequal in size in all of the species.

In addition to these two pairs of hairs, five hairs are distributed along the lateral posterior margin of this compound segment. These have been designated as shown in fig. 27, and correspond quite closely in branching and position to similar hairs occurring in *Anopheles*. Root (1924), Martini (1929) and Hurlbut (1938) are all in agreement that in the latter genus, these five hairs are homologous with similar hairs of Segment VII, and it appears to this author that there may be more justification for "homologizing" Hairs 6, 7, 9, 11 and 13 of the *Anopheles* Segment VIII-IX with those of *Culex* Segment VIII-IX

than for arbitrarily numbering those of *Culex* or for seeking similarities in *Culex* Segment VII.

6. Always single and without lateral spicules, one-half to three-fourths the length of Hair 7, inserted ventrally and slightly posterior to base of Hair 7.

7. Always multiple, with three to six branches, with lateral spicules, half of the hair lying over the segment and half over the sclerotized portion of the air tube just dorsal to the base of the acus. Its length is one-tenth to one-fifth that of the air tube.

9. Inserted at the center of the posterior margin of the segment approximately half way between the dorsal margin of the anal segment and the ventral margin of the air tube. A long hair usually attaining one-third to one-half the length of the pecten, it is always multiple with five to ten stiff, straight branches inserted in an irregularly shaped, very lightly sclerotized plate.

11. Over the lateral half of the anal segment, varying from one-third to three-fourths the length of its sclerotized portion, never exceeding it. Single and with spicules in all species.

13. Over the lateral half of anal segment. Immediately ventral to Hair 11, multiple in all species studied, with at most five branches, each branch lightly spiculate, approximately the same length or slightly shorter than Hair 11.

Hairs 6 and 7 are situated close together, as are Hairs 11 and 13, leaving Hair 9 more or less isolated between them.

Comb (c, fig. 27). Each comb scale (figs. 40, 41, 42, 43) exhibits a light, basal part of attachment varying from one-fourth to two-thirds the total length and a distal portion which is of two types. One of these is fringed with extremely fine spines or hairs, sometimes only at the apex, and in other cases at both the apex and along the sides of the scale The other type of scale is relatively long and pointed and may be very lightly fringed along its sides.

There are, then, in this subgenus, two entirely different types of comb scales combining to form three types of combs as follows: 1) a patch of 15 to 50 small scales fringed at their apices in two to four irregular rows, 2) a single or irregularly double row of 5 to 14 single, long, apically pointed spines or 3) a combination of these two types involving two anterior irregular rows of apically fringed scales and a single posterior row of long pointed ones.

With one exception, *alogistus*, all the species seen belonging to the Section *Mochlostyrax* possess a comb of the second type described above. In *alogistus* the comb is of the first type. However, in most other species of the subgenus the comb is of the first type, but in several species not generally regarded as being closely related to this section, there are two irregular tows of long, pointed spines. On the basis of the comb or comb scale types alone, no grouping of larvae has yet been made which agrees with the groupings of adults proposed by Dyar (1928) and utilized by Rozeboom and Komp (1950).

Air Tube

(Figs 27, 44)

Pecten: The teeth of the pecten vary in number from 8 to 23 and are distributed on a gently curved line occupying the basal fourth or

third of the ventro-lateral margin of the air tube. The basal three or four teeth are markedly reduced in length and are sometimes crowded unevenly on one another, but none of the apical teeth have ever been observed to be distinctly more widely separated than any of the others. The length of the teeth gradually increases from the base to the apex of the pecten, each tooth usually finely fringed on the ventral margin, but often exhibit the type of teeth encountered in the subgenus *Neoculex*. The range in variation is shown in figs. 34, 35, 36, 37 and 38. This is a character which has been used extensively in the past to separate the two subgenera, but one should exercise caution in using it alone without other aids for such a separation.

Ventral tufts (vt, figs. 27, 44). These vary in number from four to nine pairs, usually inserted in well defined pairs but not always appearing on opposite points of the air tube. Their bases are inserted in line with the pecten spines, and in no case have I observed any of the tufts to be displaced. In all the specimens I have seen, the basal are longer than the apical tufts, those intervening are gradually reduced in length toward the apex. It appears in *pilosus* that the longer basal tufts are with fewer branches than the shorter apical ones.

Lateral hairs (lh, figs. 27, 44). There are two to three pairs of fine, usually multiple hairs present on the air tube in addition to the ventral tufts. They are usually situated slightly dorsal of the lateral line, the basal pair in the vicinity of the basal ventral tuft, the apical one usually above the space between the two apical pairs of ventral tufts. Dodge (1945) states that two pairs of lateral hairs appear in all instars of North American *Melanoconion* larvae and may be used as a character to separate them from *Neoculex*. I can find only one pair in fourth instars of *Culex apicalis* and *Culex territans*, the only two species of North American *Neoculex* available to me.

Apical spine (asp, figs. 27, 44). Located on the dorsal margin of the air tube at the apex of its chitinization, this spine is inserted in a small socket which has a minute forward-projecting process. This spine is always curved anteriorly at its tip and provided in most species with a small anterior secondary spine on its basal half. I have never seen an apical spine from a known *Melanoconion* without this characteristic curvature, nor have I ever observed it to be as curved or as stout in any other *Culex* species. Figs. 28, 29, 30, 31 and 32 show its characteristic variations in form.

Segment X (Anal Segment)

(Figs. 27, 39)

There is no distinct dividing line between the anal segment and Segment VIII-IX, all of the hairs of the former occurring at its apex.

Saddle hair (sh). This fine, two to four branched hair grows from the lateral posterior margin of the sclerotized portion of the segment. Its taxonomic value has not been investigated.

Dorsal tuft. Composed of two pairs of long, heavy hairs. The inner, dorsal one (ihdt) exhibits one to five branches around the perimeter of its extreme base, varying in length from one-tenth to one-half the length of the main shaft, the basal-most of these branches being the shortest. It is my observation that the number and length of these

branchings vary considerably within any species. The outer, ventral of these two hairs (ohdt) is long, heavy and single, without branchings whatever, and is the longest of the two.

Ventral brush (vb). Composed of eight to 10 long, multiple hairs alternating in the cratal area on the ventral posterior margin of Segment X distal to the posterior edge of its sclerotization. Each is six to nine branched, the branches radiating from a bent, heavily sclerotized base. The first and sometimes the second anterior hair is usually distinctly smaller than the ones which follow. The longest hair of the brush is from two to four times as long as the sclerotization of the anal segment. I have found no characters which make this brush of value in distinguishing species within the subgenus.

DISCUSSION

Because of the lack of distinct differences in the larvae of many of the species of the subgenus *Melanoconion*, it was found necessary to investigate characters which are not commonly employed for species separation but which might prove to be of value for this purpose. The morphology of the mouthparts appear to offer such characters. There are pronounced differences in the mandibular teeth of some species, and exact studies reveal differences in the prementum and mentum, although these are more difficult to use routinely. The characters of the preclypeal spine have been shown to readily separate two species, *sursumptor* and *lucifugus*. The character of the branching and length of upper head hairs are not considered to be reliable. One species, *aikenii*, may be separated from all others studied by the presence of head hair 3.

The characters of Hairs 1 through 8 of the prothorax have made possible the division of the subgenus into smaller groups. In one species, *batesi*, Hair 10 of the prothoracic pleural group (heretofore never used as a specific character) is double and may be so in other forms not yet seen. The relationships of position and length of Hair 1 of the mesothorax and Hairs 1 through 6 of the metathorax show definite differences among species.

At the present stage of these studies, the relative lengths and positions of the minute hairs of abdominal Segments I through VII have proved to be of little value, especially those of the ventral side, which are obscure in poorly mounted specimens and which are nearly impossible to identify in mounted exuviae. Even the branching and relative lengths of the longer lateral hairs do not seem to be reliable. The characters of the comb and its scales, the development of the acus, the pecten, the relative lengths of the ventral air tube tufts, the apical spine and the details of the anal segment armature all appear to have definite value in identification. On the other hand, some of the most commonly used characters, such as the branching of the dorsal tuft hairs, the anal gills and the exact air tube proportions do not often show clear cut diagnostic differences.

SUMMARY

A study of the external larval morphology and chaetotaxy of the *Culex* subgenus *Melanoconion* has been undertaken to discover characters

which might be used to separate the species occurring within the group. All hairs have been numbered or named to serve as a basis for future work in the larval taxonomy of the Culicini.

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A REVIEW OF THE NEW WORLD ACOMATACARUS

(Acarina, Trombiculidae)[1]

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This paper is a review of the *Acomatacarus* of the Western Hemisphere including descriptions of five new species and a key for the differentiation of the twelve known species. This genus is widely distributed, having been recorded from Australasia, Europe, Africa, Mexico, and the United States. In a census of chigger populations, however, the group is represented infrequently, for the species appear to be relatively rare.

The genus *Acomatacarus* was erected by Ewing in 1942 to include those species similar to *Comatacarus* but having the "chelicera with a row of teeth on upper margin instead of a single tooth and both the first and second palpal setae simple instead of one or both being plumose or barbed." He designated *A. arizonensis* as the type species. Both genera were separated from *Leeuwenhoekia* which was diagnosed as having the dorsal setae relatively few and arising from tubercles.

On the basis of the following characters, the author is inclined to support the generic status of *Acomatacarus;* the pronounced serrations of the chelicera; the characteristically large number of dorsal setae; and the sessile nature of these setae.

Seven New World species are assigned to *Acomatacarus* and many Old World forms placed in it. Unfortunately, the Australasian species described by Womersley are so similar in appearance as to necessitate the use of statistical analyses for purposes of differentiation.

The standard measurements of the dorsal plate are expressed in microns and follow Womersley and Heaslip (1943). Figure 1 illustrates the application of these measurements to a dorsal plate possessing a nase. In tabulating these data, the holotype information is given first, followed by the paratype data. Variation among the paratypes in the branching of the palpal or galeal setae is indicated parenthetically. Leg setae are designated according to the method proposed by Brennan and Wharton (1950), as illustrated in Figure 19.[2] The plumose setae of the tarsus are not figured in the drawings but their relative positions are indicated; this omission was made for the sake of clarity. The full drawing of each mite includes the left side in its dorsal and ventral aspects. The chiggers were mounted by

[1]Contribution No. 773 of the Department of Entomology of the University of Kansas, Lawrence.

[2]There is little if any evidence, however, to justify the assumption that these setae have a sensory function and deserve the term sensory setae. Likewise, the so-called "sensillae" of the dorsal plate have not been proven to be what the name implies. For this reason, the writer has felt justified in continuing the use of the term "pseudostigmatic setae" instead of "sensillae," until more is known concerning their precise function.

Mr. L. J. Lipovsky and technicians in polyvinyl alcohol medium consisting of lactic acid, phenol and polyvinyl alcohol in the ratio 22 : 22 : 56. For much of the extremely minute and critical work, as well as for actual measuring, a phase-contrast microscope was used.

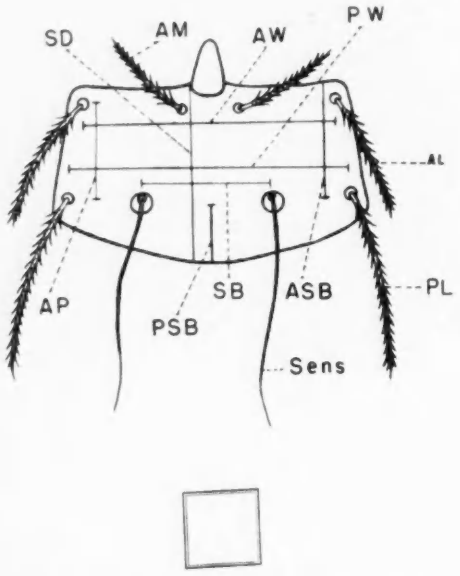

FIG. 1. Application of standard measurements to a dorsal plate possessing a nase.

AW = width between bases of antero-lateral setae.
PW = width between bases of postero-lateral setae.
SB = distance between bases of pseudostigmatic setae.
ASB = distance from anterior border to pseudostigmatic bases.
PSB = distance from posterior border to pseudostigmatic bases.
A–P = distance between antero-lateral and postero-lateral setae.
AM = length of antero-median setae.
AL = length of antero-lateral setae.
PL = length of postero-lateral setae.
SD = length of scutum (ASB plus PSB).
Sens = length of pseudostigmatic setae.

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This paper was submitted to the Department of Entomology and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Arts.

SYSTEMATIC TREATMENT

Subgeneric, generic and broader taxonomic characters based on the eleven American species are given below to avoid repetition under each species.

Genus **Acomatacarus** Ewing

All legs six segmented, bearing at apex of each tarsus two claws and a longer, more slender empodial claw between. One minute pretarsala arises lateral to base of inner claw on tarsus I and II; absent on tarsus III. Leg II shorter than legs I and III. Coxae I and II contiguous, coxa III separated; coxa I with two plumose setae, coxae II and III with one each. Microsetae absent from leg III. Triangular urstigma on posterior border of coxa I. Segments I and II of palpus fused to form a plate whose posterior border delimits the gnathosoma and passes under the scutum; palpal segments III and IV each with one branched dorso-lateral seta, the one on latter usually less branched, longer and finely tapering. Chelicera bladelike, tapering distally, serrate on at least one margin, with one or more ventral teeth and usually at least one dorsal tooth. Galeal setae usually branched. Palpal claw with two or more prongs.[3] Spiracle between coxa I and palpal femur on ventral side. Scutum usually with nase and with six plumose setae; two pseudostigmatic organs, about on a level with bases of postero-lateral setae, with long flagelliform or branched setae. Integument with fine transverse striae; eyes, two on each side, borne on ocular plates. Body setae usually numerous and sessile.

[3]In all specimens of all the species studied, it was very difficult to determine the exact structure of the palpal claw. The spurious effects resulting from the refraction of light through a rounded sclerotized surface like the palpal claw give the character a doubtful diagnostic value.

TABLE I

SUMMARY OF DIAGNOSTIC CHARACTERS

	micheneri	*senase*	*angulatus*	*polychaetus*	*whartoni*
Subterminala I and Parasubterminala I	present	absent	absent	absent	absent
Number of setae on palpal tarsus	6	4	7	7	5
Number of dorsal setae	62	52	88	120	112
Number of ventral setae	66	56	62	114	88
Approximate number of body setae	128	108	150	234	200
Length of posterior dorsal setae	36–39	35–39	39	42–50	50
Dorsal setae caudad	shorter	shorter	longer	longer	longer
Ventral setae caudad	longer	shorter	longer	longer	longer
AL / AM	<1	>1	>1	>1	>1
Nase	present	absent	present	present	present
Pseudostigmatic setae	simple	branched	simple	simple	simple
Number of plumose setae on tarsus I	23	23	32	30	28
Striated spur on tarsus III	present	absent	absent	absent	absent
Number of dorsal teeth on chelicera	1	0	3–5[4]	4	4[4]
Number of ventral teeth on chelicera	7	4	3	4	4
Length of leg I (approximate)	355	256	291	355	369
Length of leg II (approximate)	249	227	255	284	295
Length of leg II (approximate)	334	284	284	305	298
Length of ocular plate	32	27	22	23	28
Overall length	575[5]	554[5]	319	376	702[5]
Length of tarsus II / Width of tarsus II	73/24 = 3.0	77/16 = 4.8	58/23 = 2.5	60/28 = 2.1	64/25 = 2.6

[4]One is minute.

[5]Engorged.

KEY TO THE SUBGENERA OF LARVAL ACOMATACARUS

1. Chelicera with a total of about 25 teeth, bases of the proximal ventro-lateral teeth lamellate in dorsal view; scutum short, PW/SD=2.7; body setae with long branches ..... **Xenacarus**
   Chelicera with a total of 12 or less serrate teeth; scutum long, PW/SD not greater than 2.0; body setae with short branches ..... **Acomatacarus**

Subgenus **Xenacarus** Greenberg

Xenacarus Greenberg, 1951, Jour. Parasit., 37: 525. Type species: *Acomatacarus (Xenacarus) plumosus* Greenberg, by original designation.

This subgenus is distinguished from *Acomatacarus* proper by its highly modified chelicera, the greater pulmosity of its setae, the shortness of its scutum, PW/SD=2.7, and the clavate microsetae of genu I and tibia I.

Acomatacarus plumosus Greenberg

Acomatacarus (Xenacarus) plumosus Greenberg, 1951, Jour. Parasit., 37: 525.

This species was taken from a deer mouse (*Peromyscus maniculatus*) in Barber County, Kansas, on April 13, 1949. A description of the subgenus and species is contained in the paper cited above.

Subgenus **Acomatacarus** Ewing

Acomatacarus Ewing, 1942, Jour. Parasit., 28: 490–491. Type species: *Acomatacarus arizonensis* Ewing, by original designation.

Acomatacarus proper is distinguished by its simpler blade-like chelicera with a total of 12 or less serrate teeth arranged in a dorsal and/or ventral series but never with a third series between. Setae, especially those on the idiosoma, have short branches. The scutum is proportionately longer (PW/SD not greater than 2.0). Microsetae of genu I and tibia I not clavate.

KEY TO THE LARVAE OF THE NEW WORLD ACOMATACARUS

1. Scutum with anterior median process or nase; chelicera with at least one dorsal tooth 2
   Scutum without nase; chelicera with no dorsal teeth ..... **senase**
2. Tarsus III with striated spur; chelicera with only one dorsal tooth and usually five or more ventral teeth 3
   Tarsus III without striated spur; chelicera with two or more dorsal teeth and usually not more than five ventral teeth 7
3. AM longer than AL 4
   AM shorter than AL 5
4. About 62 dorsal setae; lateral seta of palpal tibia with four to six branches; genu I with one genuala and no microgenuala ..... **micheneri**
   About 100 dorsal setae; lateral seta of palpal tibia plumose; genu I with two genualae and one microgenuala ..... **bakeri**
5. Chelicera with dorsal subapical tooth 6
   Chelicera with a more proximal dorsal tooth (fig. 20) ..... **occidentalis**
6. Dorsal setae about 50; chelicera with six or seven ventral teeth; scutum narrower (PW/SD=1.6); (AW 68, PW 81, SB 23, A-P 28, AM 37, AL 41, PL 57, SD 50) ..... **chiapanensis**
   Dorsal setae more than 100; chelicera with seven to nine ventral teeth; scutum wide (PW/SD=2.0); (AW 86, PW 111, SB 32, A-P 23, AM 47, AL 52, PL 66, SD 55) ..... **hirsutus**
7. Pseudostigmatic setae branched on distal third; tarsus II with knobbed spur (fig. 22); AM longer than AL or PL ..... **arizonensis**
   Pseudostigmatic setae simple; tarsus II with normal spur; AM shorter than AL or PL 8

8. Dorsal setae more than 105; length of posterior dorsal setae about 48–50 μ; eyes equal 9
   Dorsal setae about 90; length of posterior dorsal setae about 35–42 μ; anterior eye usually larger than posterior 10
9. Posterior border of scutum angulate (fig. 12); palpal tarsus with seven setae; ventral body setae about 114; chelicera with four prominent dorsal teeth ..... **polychaetus**
   Posterior border of scutum flattened (fig. 16); palpal tarsus with five setae; ventral body setae about 88; chelicera with three prominent dorsal teeth ..... **whartoni**
10. Caudal setae 31–39 μ long; dorsal setae of first row 21–28 μ long; (AW 58, PW 72, ASB 30, A-P 26, AM 26, AL 34, PL 48, SD 54) ..... **angulatus**
    Caudal setae 42 μ long; dorsal setae of first row 26–28 μ long; (AW 64, PW 76, ASB 38, A-P 33, AM 32, AL 46, PL 52, SD 64 ..... **galli**

TABLE II

COMPARATIVE CHAETOTAXY OF SELECTED LEG SEGMENTS

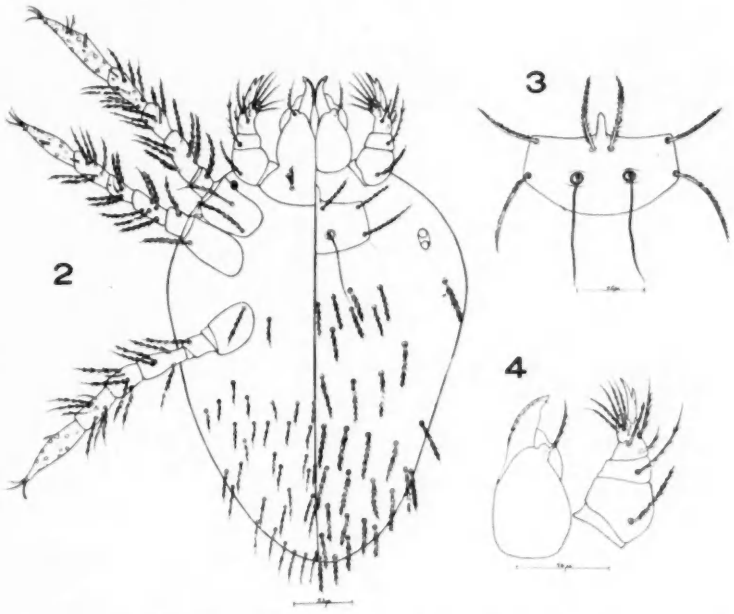
			micheneri	*sensae*	*angulatus*	*polychaetus*	*whartoni*
Leg I	Genu	plumose	5	4	5	5	5
		genuala	1	2	1	1	1
		microgenuala	0	1	1	1	1
	Tibia	plumose	8	8	9	10	9
		tibiala	2	2	2	2	2
		microtibiala	1	0	1	1	1
	Tarsus	plumose	23	23	32	30	28
		subterminala	1	0	0	0	0
		striated spur	1	1	1	1	1
		microspur	1	1	1	1	1
		parasubterminala	1	0	0	0	0
Leg II	Femur	plumose	5	5	5	5	5
		microfemorala	0	0	0	1	0
	Genu	plumose	4	4	5	5	5
		genuala	1	1	0	0	0
		microgenuala	1	0	1	1	1
	Tibia	plumose	6	6	6	6	7
		tibiala	2	2	2	2	2
	Tarsus	plumose	16	16	18	18	18
		striated spur	1	1	1	1	1
		microspur	1	1	1	0	1
Leg III	Genu	plumose	4	4	5	5	5
		genuala	1	1	0	0	0
	Tibia	plumose	6	6	6	6	6
		tibiala	1	1	1	1	1
	Tarsus	plumose	15	16	14	16	15
		mastitarsala	0	0	1	1	1
		striated spur	1	0	0	0	0

Acomatacarus arizonensis Ewing

Fig. 22

Acomatacarus arizonensis Ewing, 1942, Jour. Parasit., 28: 490–491.

The holotype, Type slide 1417, United States National Museum, has been re-examined by Wharton and his notes and sketches generally concur with the writer's observations on Mexican material presumably of the same species. The following characters are largely from Wharton's observations on the type.



Acomatacarus micheneri. Fig. 2. Dorsal and ventral aspects. Fig. 3. Scutum. Fig. 4. Right half of gnathosoma.

Palpal setae as follows: interpalpal seta 4- or 5-branched; femoral and genual setae each with two branches; tibia with three nude setae; tarsus with at least seven nude setae and basal spine; galeal seta nude.[6] Chelicera with seven dorsal and one ventrolateral teeth.[7] Anterior corners of dorsal plate well rounded; AM longer than AL or PL; pseudostigmatic setae branched on distal third. Eyes on weak ocular plates

[6]The author asked Dr. Baker to examine the galeal setae of the types. He reports a serrate condition, which can mean aborted development or simply that the branches were broken off. The writer inclines to the latter since, in at least one specimen he examined, one of the pair is serrate and the other minutely branched.

[7]Most of the specimens studied have about five dorsal teeth.

with anterior larger than posterior. Knobbed spur on tarsus II, a nymphal and adult character not present in other species of *Acomatacarus* larvae known to the writer. Brennan (*in litt.*) states that *Sauriscus ewingi* Lawrence, unrelated to *Acomatacarus*, has a knobbed spur on tarsus II and that the character is of rare occurrence in the Trombiculidae.

Mexican *Acomatacarus* sent the writer for study by Hoffmann fall into two groups. The first agrees with the type of ***arizonensis*** in the nature of the dorsal plate but differs in the branching of the palpal and galeal setae (Hosts—*Cnemidophorus labialis* and *Sceloporus rufidorsum*; locality—Isla de Cedros, Baja California, May, 1945; slides 12, 27). The second group differs markedly in the characters of the dorsal plate (Host—*Sceloporus siniferus;* locality—Acapulco, Guerrero, November 2, 1947; slide 16). Further examination will probably reveal at least one new species among this Mexican material.

Acomatacarus micheneri, new species

Figs. 2–4

This species resembles *A. chiapanensis* Hoffmann from which it may be distinguished by AM being longer than AL and by the shape and dimensions of the dorsal plate. Both species are distinguished from *A. hirsutus* and *A. bakeri* by possessing only about half their number of dorsal body setae. The close relationship of these four species is demonstrated by their similar chelicerae and the presence of a subterminala and parasubterminala on tarsus I in all but *A. bakeri*.

All specimens engorged, up to 575 μ long, 370 μ wide; eyes separated and equal, on ocular plate, 32 μ long.

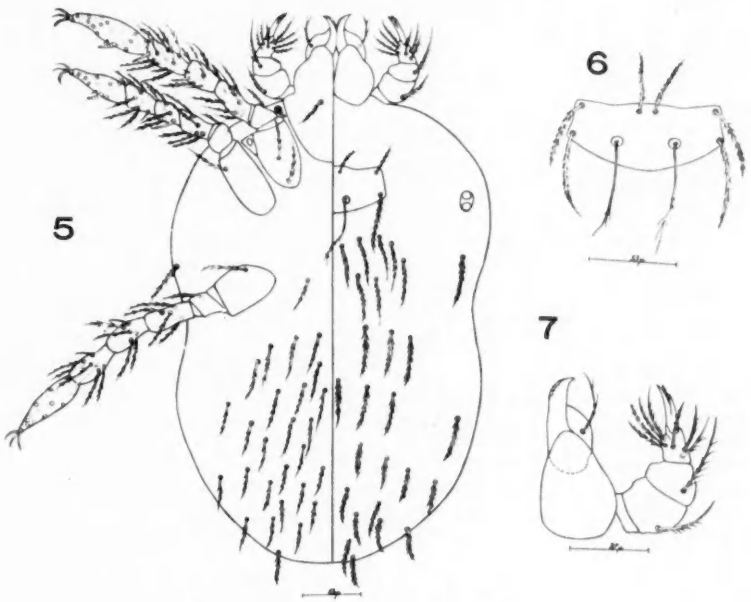
Gnathosoma—Interpalpal seta 6-branched (5–8); palpal femur with seta 12-branched on each side (10–12); genual seta 6-branched (6–12). Tibia with dorsal seta bilaterally serrate; lateral seta, 6-branched (4–6), slender and tapering; ventral seta 2-branched (2–4) and short. Tibia prolonged into bifurcate claw, inner prong sturdier and twice as long as outer. Palpal tarsus bears five sparsely branched setae and a sixth slightly longer and serrate; small, ventral spine at base of tarsus. Galeal seta with about five branches. Chelicera with seven ventral teeth and one larger, subapical dorsal tooth.

Scutum.—Quadrangular, about 1.7 times wider than long, with anterior border on either side of nase slightly concave; posterior border broadly convex; not punctate. Pseudostigmatic setae simple, their bases on a level with bases of PL, same distance from them as from each other. AM longer than AL but shorter than PL. (Other new species with AM shorter than AL.)

Legs.—Setal number as follows: Leg I: coxa, 2 plumose; trochanter, 1 plumose; femur, 6 plumose; genu, 5 plumose, 1 genuala; tibia, 8 plumose, 2 tibialae, 1 microtibiala; tarsus, 23 plumose, 1 subterminala, 1 single branched parasubterminala, 1 striated spur, 1 microspur. Leg II: coxa, 1 plumose; trochanter, 1 plumose; femur, 5 plumose; genu, 4 plumose, 1 genuala, 1 microgenuala; tibia, 6 plumose, 2 tibialae; tarsus, 16 plumose, 1 striated spur, 1 microspur. Leg III: coxa, 1 plumose; trochanter, 1 plumose; femur, 4 plumose; genu, 4 plumose,

1 genuala; tibia, 6 plumose, 1 tibiala; tarsus, 15 plumose, 1 striated spur. (Other new species without spur.)

Body Setae.—Dorsal setae about 62, shorter caudad; ventral setae about 66, more slender, less plumose than dorsals and longer caudad. Posterior dorsal setae 36–39 μ long. The pattern of the dorsal setae is obscure at times, but an approximate formulation is: 2:8:6:8:10:12:8:4:4. Ventral setae arranged as follows: 2:2:12:10:2:8:8:6:6:2:8:2:6.



Acomatacarus senase. FIG. 5. Dorsal and ventral aspects. FIG. 6. Scutum. FIG. 7. Right half of gnathosoma.

Type Material.—The *holotype*, slide 6000, and eleven *paratypes*, slides 6001–6011, were taken from a bushy-tailed wood rat (*Neotoma cinerea arizonae*), field number RBF480829-1, 10 miles west and 5 miles north of Rangely, Rio Blanco County, Colorado, at 5800 feet altitude, on August 28, 1948. Additional specimens from the same host species were taken in the following localities: 1½ miles west of Dolores, Montezuma County, Colorado, at 7000 feet and 16 miles north of Craig, Moffat County, Colorado, at 6600 feet, R. B. Finley, collector. The holotype and several paratypes have been deposited in the Snow Entomological Collection, University of Kansas. Paratypes will be placed in the collections of the United States National Museum, and the Rocky Mountain Laboratory, Hamilton, Montana.

STANDARD MEASUREMENTS OF A. MICHENERI

Slide #	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	SD	Sens
6000	67	83	28	28	21	24	41	36	52	50	78
6001	68	89	28	26	26	25	43	40	53	50	71
6002	73	101	33	25	22	26	—	—	53	47	—
6003	69	107	32	27	23	23	46	33	53	51	—
6004	72	109	33	26	22	25	38	37	50	50	—
6005	70	93	31	28	24	27	44	36	51	53	71
6006	71	92	33	26	26	25	43	38	53	53	76
6007	75	101	36	28	24	25	—	37	50	53	—
6008	70	92	32	23	22	26	39	35	52	45	75
6009	68	86	32	26	24	25	39	38	53	50	—
6010	75	97	36	28	26	28	41	39	53	55	—
6011	70	96	36	26	21	22	42	39	50	47	—
Ave.	70	96	32	27	23	23	42	37	52	51	73

Acomatacarus chiapanensis Hoffmann

Acomatacarus chiapanensis Hoffmann, 1948, Rev. Inst. Salubr. y Enferm. Trop. [Mexico], 9: 179.

The two paratypes studied differ from the original description in the following details; galeal setae branched instead of nude; lateral tibial seta on palp 3- or 4-branched instead of nude, but branches broken off. (Setae which sometimes appear nude, on closer examination may reveal tiny serrations where the branches may have broken.) Tarsus I with one subterminala and one single branched parasubterminala.

Acomatacarus bakeri Hoffmann

Acomatacarus bakeri Hoffmann, 1951, Ciencia [Mexico], 11: 29–33.

The typical chelicera and presence of a striated spur on all tarsi place this species in the *hirsutus* complex, which also includes *chiapanensis*, *hirsutus* and *micheneri*. Specimens of this species have not been available for study and comparison with its relatives.

Acomatacarus hirsutus (Ewing)

Hannemania hirsuta Ewing, 1931, Proc. U. S. Nat. Mus., 80: 17–18, pl. 3, figs. 3, 5.
Acomatacarus hirsuta Hoffmann, 1951, Ciencia [Mexico], 11: 33, figs. 1–7.

This species does not have the distal portion of the chelicera expanded as in *Hannemania;* its chelicera typifies the *hirsutus* complex. (Fig. 4.) The palps have the following setation: interpalpal seta 8-branched; femoral seta with about 15 branches; genual seta about 10-branched; tibia with lateral seta 6-branched, ventral seta 2-branched, and dorsal seta serrate; palpal tarsus with seven branched setae and a ventral spine at base. Chelicera with seven to nine ventral teeth and one larger dorsal sub-apical tooth. Tarsus I with one subterminala and one parasubterminala; difficult to observe whether or not the latter is branched.

STANDARD MEASUREMENTS OF A COTYPE[8]

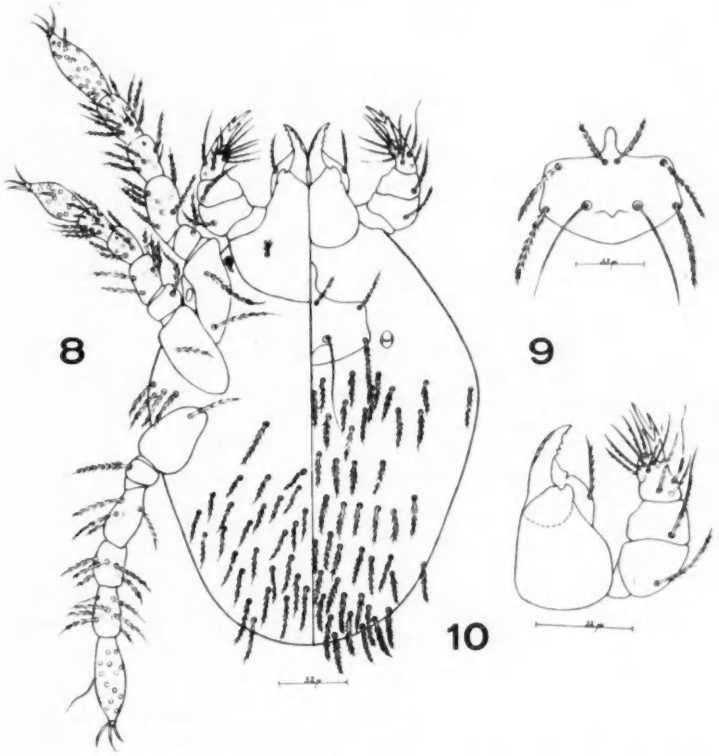
AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	SD
86	111	32	28	25	23	47	52	66	53

[8]Slide 1027, United States National Museum.

Acomatacarus occidentalis (Ewing), new combination

Comatacarus occidentalis Ewing, 1942, Jour. Parasit., 28: 489–490.

Ewing defined *Comatacarus* as having but a single dorsal and a single ventral tooth on the chelicera. The writer has not seen the type of this species but on the basis of Wharton's observations of its chelicera, feels justified in following Wharton in including it in *Acomatacarus*. The following is taken from his description (*in litt.*). Inter-



Acomatacarus angulatus. Fig. 8. Dorsal and ventral aspects. Fig. 9. Scutum. Fig. 10. Right half of gnathosoma.

palpal seta 5-branched; femoral seta 9-branched; genual seta 9-branched; tibial setae plumose except ventral seta which is 2-branched; palpal tarsus with seven plumose setae and a ventral spine at base. Galeal seta branched. Chelicera with a dorsal tooth set back from the apex and six ventral teeth. Pseudostigmatic setae simple.

Acomatacarus senase, new species

Figs. 5–7

This species can be distinguished from all other New World species of *Acomatacarus* by the absence of a nase on the dorsal plate and of dorsal teeth on the chelicera. With the accumulation of more material, these characters may prove to be justification for the erection of a new genus.

Brennan (*in litt.*) has suggested that this species may be a *Whartonia*. However, the only character of probable generic value by which it differs from *Acomatacarus* is the absence of a nase. It differs from the type species of *Whartonia*, *W. nudosetosa* (Wharton), by the plumose rather than simple body and scutal setae, and the simpler chelicera without dorsal teeth. *Whartonia whartoni* Hoffmann (1951) lacks a nase but bears plumose body and scutal setae; its chelicera, though serrate, is simpler than in the type species. It is quite possible that *Acomatacarus senase* and *Whartonia whartoni* represent links which demonstrate a close affinity between the two genera.

All specimens engorged; up to 554 μ long, 298 μ wide; eyes, generally separated and equal, on ocular plate about 27 μ long.

Gnathosoma.—Interpalpal seta about 8-branched; femur with seta 7-branched; genual seta 10-branched; tibia with slender lateral seta 4-branched, short ventral seta 3-branched, and dorsal seta bilaterally serrate. Tibia prolonged into trifurcate claw, inner prong slightly longer than outer two. Palpal tarsus with four sparsely branched setae; small, ventral spine at base. Galeal seta 5-branched (5–6). Chelicera with four ventral and no dorsal teeth. (The teeth are difficult to see since, in all the specimens, only a dorsoventral view of the chelicerae can be seen.)

Scutum.—No nase; quadrangular with anterior border sinuate; posterior border broadly convex; about two times wider than long, not punctate. Pseudostigmatic setae branched on distal third; their bases slightly in front of level of bases of PL. AL slightly longer than AM but shorter than PL.

Legs.—Setal number as follows: Leg I: coxa, 2 plumose; trochanter, 1 plumose; femur, 6 plumose; genu, 4 plumose, 2 genualae, 1 microgenuala; tibia, 8 plumose, 1 tibiala; tarsus, 23 plumose, 1 striated spur, 1 microspur. Leg II: coxa, 1 plumose; trochanter, 1 plumose; femur, 5 plumose; genu, 4 plumose, 1 genuala; tibia, 6 plumose, 2 tibialae; tarsus, 16 plumose, 1 striated spur, 1 microspur. Leg III: coxa, 1 plumose; trochanter, 1 plumose; femur, 4 plumose; genu, 4 plumose, 1 genuala; tibia; 6 plumose, 1 tibiala; tarsus, 16 plumose.

Body Setae.—Dorsal setae about 52, shorter caudad; ventral setae about 56, more slender, less plumose than dorsals and shorter caudad. Posterior dorsal setae 35–39 μ long. Dorsal setae arranged in the following pattern: 2:10:4:6:8:8:4:6:2:2. Ventral setae as follows: 2:2:8:2:8:6:4:8:4:4:6:2.

Type Material.—The *holotype*, slide 6058, and three *paratypes*, slides 6059, 6061, 6062, were taken from a hoary wood rat (*Neotoma micropus micropus*), field number RL490411-1, 3½ miles south and 1 mile west of Aetna, Barber County, Kansas, on April 11, 1949, by

Lipovsky and Loomis. The fourth *paratype*, slide 6060, was taken from a cave bat (*Myotis velifer incautus*), field number RL490410-1, at the same site, the previous day. This specimen has somewhat longer branches on the lateral and ventral setae of the palpal tibia. The holotype and two paratypes have been deposited in the Snow Entomological Collections, University of Kansas. One paratype will be placed in each of the collections of the United States National Museum and the Rocky Mountain Laboratory, Hamilton, Montana.

STANDARD MEASUREMENTS OF A. SENSAE

Slide	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	SD	Sens
6058	70	80	30	27	17	22	37	38	58	44	68
6059	66	78	28	28	24	21	36	41	53	48	—
6060	70	82	33	28	20	23	37	38	59	45	—
6061	73	89	33	28	18	20	36	42	64	48	—
6062	70	81	29	26	18	23	36	—	58	44	—
Ave.	70	82	31	28	19	22	36	40	58	46	68

Acomatacarus galli Ewing

Figs. 17, 18

Acomatacarus galli Ewing, 1946, Proc. Biol. Soc. Washington, 59: 25–26.

A cotype of *Acomatacarus galli* Ewing (slide 1516, United States National Museum) differs from the original description as follows: chelicera with three dorsal recurved teeth and three ventral teeth; galeal seta about 4-branched. The following additional data are given to supplement the original description: interpalpal seta about 15-branched; femoral and genual setae each with about 12 branches. Tibia with lateral seta probably 4-branched; ventral seta 4-branched; and dorsal seta serrate. Palpal tarsus with seven sparsely branched setae and small basal spine. Palpal claw with three or four prongs, inner prong longest.

STANDARD MEASUREMENTS OF A. GALLI

A	PW	SB	ASB	PSB	A-P	AM	AL	PL	SD
64	76	26	38	26	33	33	46	52	64

Acomatacarus angulatus, new species

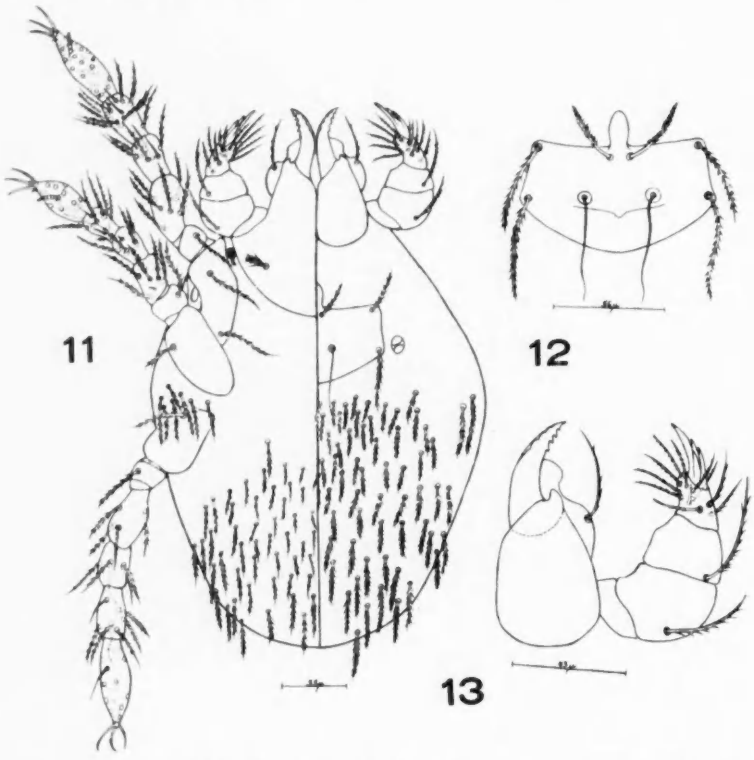
Figs. 8–10

This species closely resembles *A. galli* from which it differs in the standard measurements of the scutum and slightly shorter body setae. Further studies of their ecology and life history may prove that *A. angulatus* is a subspecies of *A. galli*. For the present, the writer feels justified in considering them distinct species while emphasizing their closeness. These two species likewise bear a strong resemblance to many of the Australasian forms, *e.g.*, *A. echidnus* Womersley and *A. athertonensis* Womersley. The group as a whole possesses a scutum of characteristic shape, similar chelicerae, and about the same number of dorsal and ventral body setae.

Specimens unfed to slightly engorged; 319–383 μ long, and 195–220 μ wide; eyes contiguous, anterior slightly larger than posterior, on weak ocular plate 22 μ long.

Gnathosoma.—Interpalpal seta about 12-branched; palpal femur

with seta about 10-branched; genual seta about 9-branched; tibia with lateral seta 3-branched, slender to flagelliform, and ventral seta short, 3-branched (3–4), and dorsal seta serrate. Tibia prolonged into tri- or quadrifurcate claw with inner prong slightly longer than others. Palpal tarsus with seven sparsely branched setae; small, ventral spine at base of tarsus. Galeal seta 6-branched (5–6). Chelicera with three dorsal recurved teeth (3–5) and a minute subapical one, and three ventral teeth.



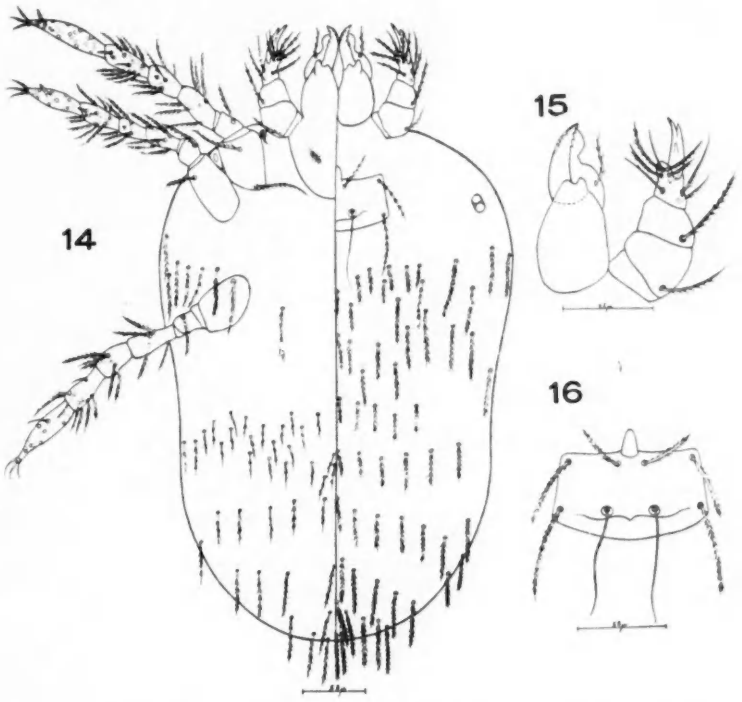
Acomatacarus polychaetus. FIG. 11. Dorsal and ventral aspects. FIG. 12. Scutum. FIG. 13. Right half of gnathosoma.

Scutum.—Posterior border angulate; sides slightly concave; about 1.3 times as wide as long; not punctate. Pseudostigmatic setae simple, their bases closer to bases of PL than to each other; usually bracketed posteriorly by a ridge in the scutum.

Legs.—Setal number as follows: Leg I: coxa, 2 plumose; trochanter, 1 plumose; femur, 6 plumose; genu, 5 plumose, 1 genuala, 1 microgenuala; tibia, 9 plumose, 2 tibialae, 1 microtibiala; tarsus, 32 plumose, 1 striated spur, 1 microspur. Leg II: coxa, 1 plumose; trochanter,

1 plumose; femur, 5 plumose; genu, 5 plumose, 1 microgenuala; tibia, 6 plumose, 2 tibialae; tarsus, 18 plumose, 1 striated spur, 1 microspur. Leg III: coxa, 1 plumose; trochanter, 1 plumose; femur, 4 plumose; genu, 5 plumose; tibia, 6 plumose, 1 tibiala;[9] tarsus, 14 plumose, 1 mastitarsala.

Body Setae.—Dorsal setae about 88, longer caudad; ventral setae about 62, less plumose than dorsals and longer caudad. Posterior



Acomatacarus whartoni. FIG. 14. Dorsal and ventral aspects. FIG. 15. Right half of gnathosoma. FIG. 16. Scutum.

dorsal setae about 39 μ long. Dorsal setae arranged approximately as follows: 2:6:8:10:2:8:12:16:8:8:8:6:2. Ventral setae: 14:2:10:2:12:10:6:6:6.

Type Material.—The *holotype*, slide 6063, and seven *paratypes*, slides 6064–6070, were taken from a deer mouse (*Peromyscus maniculatus*), field number HWS1258, 4 miles west and 1 mile south of Logan, Norton County, Kansas, on October 26, 1946, by Mr. H. Setzer and Mr. E. Marks. The holotype and several paratypes have been placed

[9]Slide 6064 has 7 plumose setae and 1 tibiala.

in the Snow Entomological Collections, University of Kansas. Paratypes will be placed in the collections of the United States National Museum and the Rocky Mountain Laboratory, Hamilton, Montana.

STANDARD MEASUREMENTS OF A. ANGULATUS

Slide	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	SD	Sens
6063	59	69	26	32	23	25	26	33	53	55	71
6064	59	71	25	31	25	28	25	37	51	55	50[10]
6065	55	71	26	28	28	26	26	32	47	60	69
6066	58	73	26	31	24	26	26	33	47	55	—
6067	57	75	26	26	23	26	26	31	45	50	43[10]
6068	58	77	26	31	23	28	24	34	48	54	71
6069	58	71	26	28	25	24	25	33	50	53	69
6070	58	71	25	30	25	26	24	35	48	50	64
Ave.	58	72	26	30	25	26	26	34	48	54	69

Acomatacarus polychaetus, new species

Figs. 11–13

The very abundant body setae and the standard measurements of the scutum will distinguish this species from *A. angulatus* and *A. galli;* lengths of various structures summarized in Table I indicate other dissimilarities. Unlike the other species, *A. polychaetus* has a microseta on femur II. It is termed microfemorala, as an addition to the terminology of Brennan and Wharton.

Unfed specimens about 376 μ long, and 235 μ wide. Eyes, contiguous and subequal, on moderately sclerotized ocular plate 23 μ long.

Gnathosoma.—Interpalpal seta at least 12-branched; palpal femur well rounded laterally with seta about 9-branched; genual seta 8-branched. Tibia with lateral seta 4-branched; short ventral seta 3- or 4-branched; dorsal seta serrate. Palpal claw tri- or quadrifurcate, inner prong slightly longer than others. Palpal tarsus with seven sparsely branched setae; small, ventral spine at base. Galeal seta 4-branched. Chelicera with four dorsal recurved teeth and four ventral teeth.

Scutum.—Posterior border broadly convex. Pseudostigmatic setae simple, their bases closer to bases of PL than to each other, and bracketed posteriorly by a scutal ridge. About 1.5 times wider than long. AL longer than AM but shorter than PL. Punctations densest between bases of AM and pseudostigmatic setae.

Legs.—Setal number as follows: Leg I: coxa, 2 plumose; trochanter, 1 plumose; femur, 6 plumose; genu, 5 plumose, 1 genuala, 1 microgenuala; tibia, 10 plumose, 2 tibialae, 1 microtibiala; tarsus, 30 plumose, 1 striated spur, 1 microspur. Leg II: coxa, 1 plumose; trochanter, 1 plumose; femur, 5 plumose, 1 microfemorala; genu, 5 plumose, 1 microgenuala; tibia, 6 plumose, 1 microtibiala; tarsus, 18 plumose, 1 striated spur. Leg III: coxa, 1 plumose; trochanter, 1 plumose; femur, 4 plumose; genu, 5 plumose; tibia, 6 plumose, 1 tibiala; tarsus, 16 plumose, 1 mastitarsala.

Body Setae.—Dorsal setae about 120, longer caudad; ventral setae

[10]Not included in average because setae are not entire.

about 114, less plumose, more slender than dorsals and longer caudad. Posterior dorsal setae 42–50 μ long. Body setae too numerous to make a worthwhile formulation.

Type Material.—The *holotype*, slide 6076, and *paratype*, slide 6077, were taken from a wood mouse (*Peromyscus leucopus noveboracensis*), field number K480330-4 and 5, 3 miles south of Fayetteville, Washington County, Arkansas, on March 30, 1948, by Lipovsky and L.

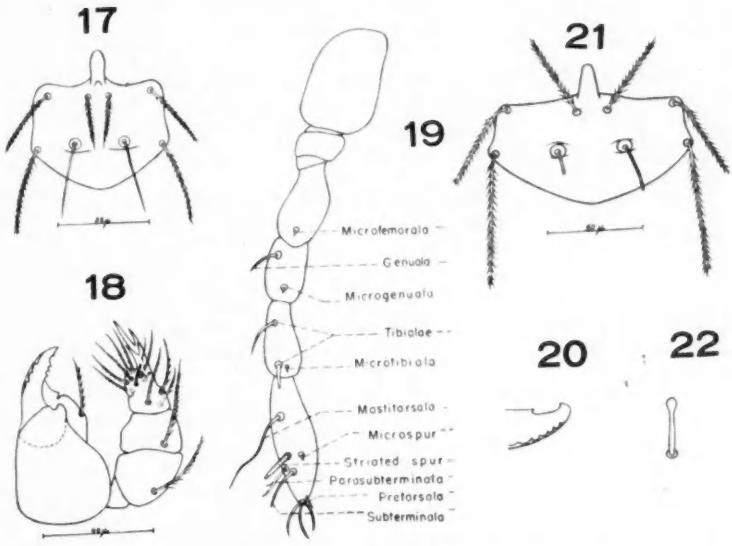


FIG. 17. Scutum of *A. galli*. FIG. 18. Right half of gnathosoma of *A. galli*. FIG. 19. Specialized setae of the legs. FIG. 20. Portion of right chelicera of *A. occidentalis* (after Wharton, *in litt.*). FIG. 21. Scutum of *A. hirsutus*. FIG. 22. Knobbed spur on tarsus II of *A. arizonensis*.

Koger. The holotype has been deposited in the Snow Entomological Collections, University of Kansas. The paratype will be placed in the collections of the United States National Museum.

STANDARD MEASUREMENTS OF A. POLYCHAETUS

Slide	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	D	Sens
6076	71	86	36	36	22	28	33	51	56	60	57
6077	70	78	31	33	26	31	38	47	55	60	52
Ave.	70	82	33	34	24	29	35	49	55	60	54

Acomatacarus whartoni, new species

Figs. 14–16

This species lacks a spur on tarsus III which readily separates it from *A. hirsutus*. The somewhat straighter posterior border of the scutum will distinguish it from *A. polychaetus* and *A. angulatus* and other species with angulate posterior scutal borders.

Engorged length 702 μ by 418 μ wide; eyes, contiguous and subequal, on weak ocular plate 28 μ long.

Gnathosoma.—Interpalpal seta about 12-branched; palpal femur with seta 7-branched; genual seta about 11-branched. Tibia with lateral seta about 4-branched, flagelliform (branches broken off); ventral seta 4- or 5-branched; dorsal seta serrate. Palpal claw trifurcate, inner prong slightly longer than others. Palpal tarsus with four sparsely branched setae and one nude; small, ventral spine at base. Galeal seta 6- to 8-branched. Chelicera with three prominent dorsal recurved teeth and a minute sub-apical one, and four ventral teeth.

Scutum.—Rectangular with slightly convex posterior border. Pseudostigmatic setae simple, their bases equidistant from each other and bases of PL, and at same level; bracketed posteriorly by scutal ridge. Scutum more punctate anterior to ridge. About 1.5 times wider then long.

Legs.—Setal number as follows: Leg I: coxa, 2 plumose; trochanter, 1 plumose; femur, 6 plumose; genu, 5 plumose, 1 genuala, 1 microgenuala; tibia, 9 plumose, 2 tibialae, 1 microtibiala; tarsus, 28 plumose, 1 striated spur, 1 microspur. Leg II: coxa, 1 plumose; trochanter, 1 plumose; femur, 5 plumose; genu, 5 plumose, 1 microgenuala; tibia, 7 plumose, 1 tibiala, 1 microtibiala; tarsus, 18 plumose, 1 striated spur, 1 microspur. Leg III: coxa, 1 plumose; trochanter, 1 plumose; femur, 4 plumose; genu, 5 plumose; tibia, 6 plumose, 1 tibiala; tarsus, 15 plumose, 1 mastitarsala.

Body Setae.—Dorsal setae about 112, longer caudad; ventral setae about 88, more slender and also longer caudad. Arrangement of anterior rows unclear.

Type Material.—***Holotype***, slide 6078, taken from an eastern cottontail rabbit (*Sylvilagus floridanus alacer*), field number L480329-6, 2 miles south of Winslow, Washington County, Arkansas, March 29, 1948, by Lipovsky. Deposited in the Snow Entomological Collections, University of Kansas.

STANDARD MEASUREMENTS OF A. WHARTONI

Slide	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	SD	Sens
6078	71	87	30	35	24	30	37	46	58	60	66

HOST LIST

angulatus		*Peromyscus maniculatus*	deer-mouse
arizonensis	(1) [11]	*Callisaurus draconoides ventralis*	eastern gridiron-tailed lizard
	(2)	*Dipsosaurus dorsalis dorsalis*	northern crested lizard
	(3) [12]	*Cnemidophorus labialis*	racerunner
	(4)	*Sceloporus magister rufidorsum*	spiny lizard
	(5)	*Sceloporus siniferus*	scaly lizard

[11] These numbers serve to correlate locality with host data.

[12] (3), (4) and (5) are placed in *arizonensis* for purposes of this table. (See discussion of *arizonensis*.)

bakeri	*Peromyscus truei gratus*	piñon mouse
chiapanensis		undetermined badger
galli		chicken
hirsutus	*Perognathus californicus californicus*	California pocket mouse
micheneri	*Neotoma cinerea arizonae*	bushy-tailed wood rat
occidentalis		"common ground squirrel"
polychaetus	*Peromyscus leucopus noveboracensis*	wood mouse
senase	*Neotoma micropus micropus*	hoary wood rat
	Myotis velifer incautus	cave bat
whartoni	*Sylvilagus floridanus alacer*	eastern cottontail rabbit

DISTRIBUTION AND DATE COLLECTED

angulatus	Norton County, Kansas	Oct. 26, 1946
arizonensis (1)	Near Wickenburg, Arizona	May 11, 1937
(2)	Palm Desert, Riverside County, California	April 12, 1950
(3) & (4)	Isla de Cedros, Baja California, Mexico	May 19, 1945
(5)	Acapulco, Guerrero, Mexico	Nov. 2, 1947
bakeri	Pedregal de San Angel, Mexico, D. F.	Sept., 1950
chiapanensis	Finca "La Esperenza," Chiapas, Mexico	May, 1945
galli	Uvalde, Texas	Jan. 13, 1943
hirsutus	Berkeley, California	
micheneri	Rio Blanco County, Colorado	Aug. 29, 1948
	Montezuma County, Colorado	Sept. 9, 1948
	Moffat County, Colorado	Sept. 2, 1948
occidentalis	Lake Pillsbury, California	Sept. 10, 1939
polychaetus	Washington County, Arkansas	Mar. 30, 1948
senase	Barber County, Kansas	April 11, 1949
whartoni	Washington County, Arkansas	Mar. 29, 1948

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REVUE DU PALUDISME ET DE MEDECINE TROPICALE, 36, rue Sainte-Croix-de-la-Bretonnerie, 36, Paris (IVe), France.

Two recent numbers of this journal deserve special mention. The first, a special number under date of October, 1951, is dedicated to the memory of Joseph Pelletier and J.-B. Caventou, codiscoverers of quinine, the occasion of this publication being the erection of a monument in Paris in March, 1951, to replace a similar monument to these men erected in 1900 and destroyed during the occupation of France in 1942. This number, in its 108 pages, contains much information on the lives and work of these men, a color portrait of each, a facsimile of a letter to the Academie Royale des Sciences (Paris) in 1827, and much other interesting and informative material.

The second number of special interest, Année 9, no. 91, December 15, 1951, consists of a comprehensive index of articles, arranged by subjects, that have appeared in the *Revue* since its initiation in 1939.—M. T. J.

SURFACE CONDITIONS LIMITING LARVAL SITES OF CERTAIN MARSH MOSQUITOES[1]

WILLIAM R. HORSFALL AND ARTHUR P. MORRIS
University of Illinois
Urbana, Illinois

Literature on the bionomics of mosquitoes that develop in shallow bodies of ground water, while replete with accounts of gross distribution of larvae, leaves much in doubt about the minute aspects of developmental sites. Among the more detailed works dealing with species in the United States are those based on observations in certain large reservoirs and natural lakes of the South where large areas of fairly uniform conditions obtain. Bang *et al.* (1943) showed that larvae of *Anopheles walkeri* (Theob.) occurred in Reelfoot Lake in Tennessee wherever the water was densely shaded by emergent vegetation and were especially abundant in communities of cutgrass (*Zizaniopsis*) shaded by willow or buttonbush. Eyles (1948) demonstrated that larvae of both *A. walkeri* and *A. quadrimaculatus* Say were abundant in areas shaded by cutgrass or willow wherever the mean maximum surface temperature of the water did not exceed 31° C. These species were absent in all water densely shaded by water lily and cow lily. Furthermore, no larvae of these species were found in locations where the mean maximum surface temperature reached 40° C. Relatively few larvae of either *A. punctipennis* (Say) or *A. crucians* Wied. occurred even in the cooler water in the areas observed. Hess & Hall (1945) reported that the most important aspects of plants in relation to *A. quadrimaculatus* were (1) absence of canopy species and (2) abundance of subsurface plants intruding into the water surface in the reservoirs of the Tennessee River. Larvae of this species were rare in communities of plants with naked emergent stems.

An opportunity to explain some of the apparent discrepancies between the observations cited above came during 1950. A marsh near Muncie, Illinois, located in the eastern part of the state at about 40° north latitude provides a wide range of temperature and plant communities. The situation permitted establishment of groups of stations of uniform size and representing different surface conditions. The marsh covers an area roughly 2 acres in extent with a soft mud bottom some 30 cm. deep overlaid by water of varying depth to about 20 cm. The water level remained nearly constant during the summer as losses from all causes were balanced by inflow from marginal seepage and springs. Runoff from the scant watershed caused only a slight temporary elevation of the surface even after heavy rains. Temperature changes in the surface water showed certain consistent features. At night minimum temperatures were much the same in all parts. Maximum surface temperatures were lowest on the side of the principal affluent

[1]Contribution of the Department of Entomology, University of Illinois.

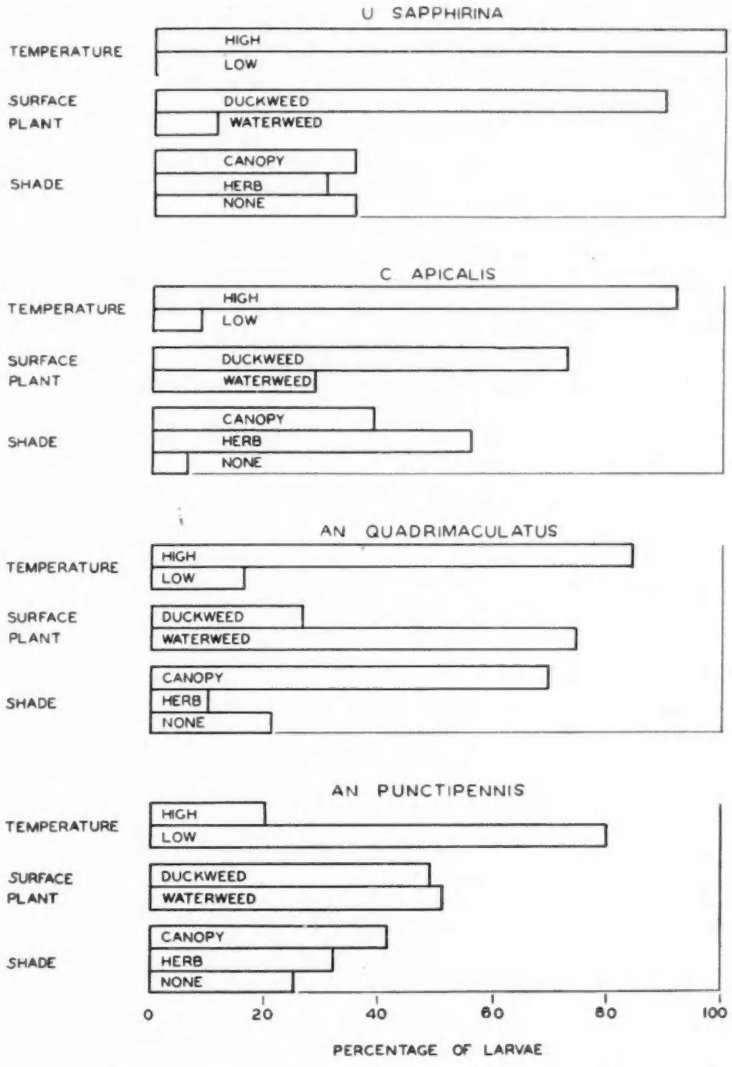

FIG. 1. Effect of surface features of a shallow marsh on the distribution of larvae of mosquitoes.

spring, were progressively higher toward the center of the marsh and continued at about the same level over the rest of the marsh. Water in all parts of the marsh showed a slight drift, hardly a current, toward the effluent. Irregular areas of well defined communities of plants were present. Waterweed alone and waterweed interlaced in fairly dense stands of the leafy erect composites, *Bidens spp.*, occupied much of the marsh. In one area duckweed alone and in combination with leafy erect composites more or less covered the water, at least during August and September.

METHODS

Three groups of three stations selected on the basis of a census made during 1949 were observed during the season of larval occurrence in 1950. One group of three stations was located in an area where the temperature of the surface water was uniformly low, and two groups

TABLE I

SUMMARY DESCRIPTION OF COLLECTING STATIONS IN MUNCIE MARSH, 1950

Station	Mean maximum temperature of surface water	Shade	Surface vegetation
1	18° C.	canopy	waterweed
2	18	herb	"
3	18	none	"
4	25	canopy	"
5	25	herb	"
6	25	none	"
7	24	canopy	duckweed
8	24	herb	"
9	24	none	"

of three stations each were established in areas where the surface water was consistently warmer during the middle of the day. The cold region and one of the warmer ones supported an abundant growth of waterweed floating in and beneath the surface. The other warm area came to be covered by a blanket of duckweed during the period of maximum larval abundance. One station in each group was maintained free of emergent herbs or other shade; another supported a dense stand of leafy erect composites, mostly *Bidens spp.*, that grew to a height of 4–6 feet in August; and a third station in each group was kept free of emergent herbs but was uniformly shaded by a low flat burlap canopy suspended about 1 meter above the water. Each station was approximately 3 meters square, and all in each group were nearly adjacent to one another. Table I contains a summary description of the three groups of stations.

Observations and collections were made once each week during the interval between late May and late October. Comparisons between larval incidence by stations are based on collections of larvae taken in 30 dipperfuls of water from each site during the middle part of the

day. Larvae were separated from possible predators and were transferred to collecting jars and removed to the laboratory for rearing and identification. About mid-afternoon of the day collections were made, temperatures of the surface centimeter of water were taken at each station by means of a mercury thermometer. Readings of maximum-minimum thermometers left in the water from week to week checked closely with the maximum records on collecting days. A summer mean-maximum temperature was calculated for each plot by taking an average of the high records for each day of collection, and agreement between plots was very close for each area. Thus the summer mean-maximum figure was 18° C. for the cold area, 24° C. for one of the warm areas and 25° C. for the other of the warm areas.

RESULTS

Muncie Marsh was a fortunate site for observing the influence of conditions at the surface of a marsh on the minute distribution of larvae of certain species of mosquitoes. Here was a shallow body of water practically free of minnows and apparently well suited to extensive development of the usual species occurring in permanent ground pools. The surface temperature was moderate all summer and well defined communities of plants provided cover. However, several consistent marked differences were seen in the actual numbers of larvae in different areas. These differences shown in Table II and figure 1, of course, reflect not only suitability of the areas as larval sites but as oviposition sites as well. No attempt has been made to determine which is more affected by the surface features.

Larvae of six species of mosquitoes were collected from the marsh during the summer of 1950. However, only four species occurred in numbers sufficient for comparative purposes. Numerically, *Uranotaenia sapphirina* (O.S.) dominated the collection with *Anopheles punctipennis* and *Culex apicalis* Adams in second and third places respectively. *Anopheles quadrimaculatus* was about one half as common as *A. punctipennis* in the collection. Only 23 larvae of *Culex erraticus* (D. & K.) and two of *A. occidentalis* D. & K. were collected.

The most abundant species, *Uranotaenia sapphirina*, occurred principally in water with higher mean maximum summer temperature that supported duckweed regardless of type of shade as is shown in figure 1. Nearly 90 percent of the larvae of this species were in such communities. Larvae were seen to lie nearly horizontally beneath mats with their mouthparts grasping roots of the tiny plants and the tips of their siphons open at the surface between the leaves. Their mottled yellowish green color blended well with the plants among which they floated. Whatever the favoring role, a duckweed cover was sufficient for determining the specific distribution of this species within a favorable range of temperature. The population of this species was about equally distributed between the stations where they occurred without regard to shade. No larvae of this species were found in the cold stations.

Larvae of *Culex apicalis*, like those of the former species, inhabited water with the higher afternoon temperature where duckweed was present. This species, unlike the *Uranotaenia*, required shade. While

TABLE II

RELATION BETWEEN LARVAL INCIDENCE AND SURFACE FEATURES OF MUNCIE MARSH, MUNCIE, ILLINOIS, MAY TO OCTOBER, 1950

SPECIES	COLLECTING INTERVAL		LARVAE COLLECTED							
			Total	Temperature		Shade			Surface Vegetation†	
	Range	Peak		High*	Low	Canopy	Herb	None	Waterweed	Duckweed
Uranotaenia sapphirina	June 13 Sept. 18	July 24 Aug. 21	756	378	0	263	218	275	77	679
Culex apicalis	May 27 Sept. 29	July 17 Aug. 21	485	232	20	175	280	30	124	341
Anopheles quadrimaculatus	July 31 Oct. 29	Aug. 21 Sept. 4	283	134	15	199	23	61	199	69
Anopheles punctipennis	May 20 Oct. 29	Aug. 7 Sept. 18	585	97	391	244	186	155	101	93
Anopheles occidentalis	.....	.....	2	1	0	1	1	0	1	1
Culex erraticus	Aug. 7 Sept. 29	....	23	11	0	17	6	0	22	1

*Average number collected in one area represented by stations 4–9 of Table I.
†Collections from stations with high temperature.

some larvae were found in the colder water their number amounted to less than 10 percent of the total population. Over 70 percent of the population occurred in mats of duckweed and less than 30 percent were in communities of waterweed. Less than 10 percent of the population were found in unshaded stations and nearly 60 percent were in stations overgrown with the leafy erect composites, *Bidens spp.*

Anopheles quadrimaculatus, like the two preceding species, occurred principally in warm water, but otherwise the sites were very different. Over 80 percent of the population in Muncie Marsh occupied stations where the water was warmer in midafternoon. Communities of waterweed provided sites for about 75 percent of the population. The numerous shallow pockets of water above and between the interlaced stems of waterweed provided sites for most of the larvae. Such communities when covered by a low burlap canopy yielded about 70 percent of the larvae. Obstructions in the form of herbaceous shade apparently inhibited populations of this species. Possibly sites in small pockets of water in open sun were momentarily overheated at intervals thereby making unshaded communities of waterweed only partially suitable for this species. Since the waterweed community under the canopy where most larvae were collected and that in the nearby unshaded station were otherwise similar, short-term differences in surface temperature might explain the differences in populations. The favorable mean maximum surface temperature apparently is in the range of 25–31° C. on the basis of results obtained by Eyles (1948) and those reported here. Certainly 18° C. was unfavorably low and 40° C. was prohibitively high.

Populations of larvae of *Anopheles punctipennis* were high in only one situation. Stations in the area of colder water produced 80 percent of these larvae thereby making this the only species so favored. Comparisons between densities of populations, surface vegetation and shade were made only in the two areas of warmer water in order to better relate them to the other species. Both waterweed and duckweed supported similar densities of larvae. Shaded water whether by canopy or herb seemed to provide better conditions for survival than unshaded water.

Variations were noted in the incidence of species as the season advanced. *Culex apicalis* and *Uranotaenia* were most numerous during the month between July 20 and August 21 with minor peaks of abundance during late June and about mid-September. *Anopheles punctipennis* was present from late May until the end of October, but most larvae were collected in the interval between August 7 and September 18. Larvae of *A. quadrimaculatus* were most numerous during late August, and a few were found as late as the end of October. This species appeared later during 1950 than 1949 possibly because the summer was far cooler than average.

SUMMARY

The relative effects of shade, surface vegetation and mean maximum temperature of the surface water on the minute distribution of larvae of four common mosquitoes were determined for a shallow marsh in central Illinois. A combination of a summer mean-maximum water

temperature of 24–25° C. and a surface vegetation of duckweed provided sites of greatest larval abundance for *Uranotaenia sapphirina* and *Culex apicalis*. *Anopheles quadrimaculatus* was more abundant in the warmer water broken by waterweed and shaded by a canopy. *A. punctipennis* was far more commonly collected in areas where the mean maximum water temperature was 18° C. with little regard for surface vegetation or shade. Chronologically, peak populations of larvae occurred as follows: first, *C. apicalis*, second, *U. sapphirina*, third, *A. quadrimaculatis* and fourth, *A. punctipennis*.

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AN INTRODUCTION TO ACAROLOGY, by EDWARD W. BAKER and G. W. WHARTON. xiii+465 pp. Frontispiece, 2 plates + 377 figs. The Macmillan Co. Price, $10.00.

This work is what the title implies, an introduction to the vast and relatively poorly known field of Acarology. The authors, two of the leading younger workers in the field, have had the courage and foresight, together with the technical knowledge and experience, to enable them to produce the first American work on this subject.

The approach is essentially taxonomic. The introduction (pages 1–35) discusses techniques and lays down a morphological background; the remainder of the book, with the exception of the index, takes up mites and ticks according to suborders, "groups" (here, a category between the suborder and family) and families. Keys lead only as far as families, (sometimes subfamilies) though genera and subgenera are listed, with type citations. For each family, a brief diagnosis, usually a third of a page or less, is given; this is often accompanied or sometimes replaced by, a discussion of the taxonomic status, economic or medical importance, or other pertinent material. The illustrations are freely interspersed and appear to be quite adequate; they are all line drawings.

The work may prove a disappointment to many, but only because of the necessarily brief way in which the Acarina are treated. To treat adequately, in one volume, a complex of more than two hundred (!) families, is beyond one's reasonable expectations. The authors have condensed an immense amount of information in this volume and by selecting the important references to the various families, they have opened the way to the use by the student of the original sources.—M. T. J.

NOTICES AND BOOK REVIEWS

INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE: PROPOSED AMPLIFICATION CLARIFICATIONS AND EXTENSIONS TO BE CONSIDERED BY THE INTERNATIONAL CONGRESS OF ZOOLOGY, COPENHAGEN, 1953.

Notice issued by the Secretary to the International Commission on Zoological Nomenclature.

Zoologists and palaeontologists are reminded that at its meeting held in Paris in 1948 the Thirteenth International Congress of Zoology decided that a number of general problems of great importance involving the text of the International Code of Zoological Nomenclature should be brought forward for decision at the next (Fourteenth) International Congress of Zoology at its meeting to be held in Copenhagen in 1953. The Paris Congress further decided that, as a preliminary to the submission of these problems to the Copenhagen Congress, the Secretary to the International Commission on Zoological Nomenclature should confer with interested specialists and, having done so, should submit comprehensive Reports, with recommendations.

In pursuance of the duties so entrusted to me, I have prepared papers on each of the problems remitted to me for Report, in each of which I have set out the issues on which, as it appears to me, the Copenhagen Congress will need to take decisions. In these papers also I have submitted for consideration a number of suggestions based upon such preliminary consultations as it has already been possible to hold. The object of these papers is to elicit expressions of opinion on the issues involved from as wide a circle as possible of interested specialists.

The subjects dealt with in the papers referred to above are the following:

(1) Emendation of zoological names: proposed substitution for Article 19 of simple clear-cut rules capable of being easily applied (Commission's reference Z. N. (S.) 356);

(2) Clarification and amplification of the rules relating to the naming of families and lower categories of suprageneric rank (Commission's reference Z. N. (S.) 357);

(3) Proposed introduction of rules for regulating the naming of Orders and higher taxonomic categories (Commission's reference Z. N. (S.) 360);

(4) Species to be accepted as the type species of a nominal genus, the name of which was published in a generic synonymy, if names so published are to be treated as possessing nomenclatorial availability (Z. N. (S.) 387);

(5) Application to be given to a trivial name which, when first published, was applied to a particular species or specimen but which is stated also to be a substitute name for some previously published name (Commission's reference Z. N. (S.) 361);

(6) Neotypes: question whether this class of type specimen should be officially recognized and, if so, under what conditions (Commission's reference Z. N. (S.) 358);

(7) The means to be devised for securing stability in zoological nomenclature (Commission's reference Z. N. (S.) 359).

A special volume (vol. 7) of the *Bulletin of Zoological Nomenclature* has been allotted for the publication of the foregoing papers, which it must be understood constitute an important installment of the Agenda on nomenclature questions of the Copenhagen Congress next year. Parts 1/2 containing the first installment of the above papers will be published on 25th February, 1952; the whole of the remainder of the volume will be published within the next six weeks.

The object of the present NOTICE is to draw the attention of zoologists and palaeontologists to the arrangements being made for the consideration of the foregoing problems by the Copenhagen Congress next year, and to express the hope that Nomenclature Committees of museums and other scientific institutions and also as many individual specialists as possible will furnish as soon as possible

answers to the questions specifically asked in the concluding paragraph in each of the seven papers enumerated above regarding the action which, in their opinion or, in the case of Committees, in the opinion of their members, it is desirable that the Copenhagen Congress should take on each of the important problems involved. It is particularly hoped that there will be a wide and representative response to the present appeal, so that the proposals to be submitted to the Copenhagen Congress may be such as will command the widest possible measure of support among the general body of zoologists and palaeontologists, both those engaged on taxonomic work and also those engaged in the teaching of zoology and geology and those working in the various fields of applied biology.

Nomenclature Committees and individual specialists who respond to the present appeal for assistance and advice will render a double service if they will be so good as to assist the International Commission by observing the following procedure when furnishing statements of their views: (1) Where comments are furnished on two or more of the general problems enumerated above, the comments furnished on each of those problems should be on separate sheets of paper. (2) Every comment furnished should be clearly marked with the Commission's Reference Number as indicated in the list given above. (3) Comments should be typewritten, on one side of the paper only, with wide margins and should be furnished in duplicate.

In order that there may be sufficient time to prepare the Reports called for by the Paris Congress—and thus to make those Reports available well ahead of the Copenhagen Congress—it is particularly hoped that Nomenclature Committees and individual specialists responding to the present appeal be so good as to dispatch their comments as promptly as possible. They should in any case reach me not later than 31st July, 1952.

All communications relating to the foregoing matters should be addressed to myself, as Secretary to the International Commission on Zoological Nomenclature (28 Park Village East, Regent's Park, London, N. W. 1, England).

FRANCIS HEMMING,
Secretary to the International Commission on Zoological Nomenclature.

20th February, 1952.

Though this notice was received too late for earlier publication, the Editor feels it is still worthy of bringing to the notice of the Society.—ED.

BIOLOGY OF THE LEAF MINERS, by ERICH MARTIN HERING. iv+420 pp., 2 pl., 180 figs. Dr. W. Junk, The Hague, 1951. Price, 36 guilders.

Dr. Martin Hering is the foremost student of leaf miners of the world and for more than 30 years has studied these insects in Central and Southern Europe and the Canary Islands. He has published over 100 papers and is well qualified for the task he has completed.

The Biology of the Leaf Miners is written in perfect English. The binding is poor but the printing is excellent. It is copiously illustrated by Dr. Hering's accurate and detailed sketches of leaf mines. Sixty-three pages of bibliography include over 1000 references. As in all new texts, there are some typographical errors, a considerable number of these being included as Errata.

A large part of the book is a summary of the studies of leaf miners published elsewhere. The book shows evidence of a growing knowledge of leaf miners which Dr. Hering has incorporated in this work. Subjects such as types of mines and groups of insects mining leaves have been discussed previously by leaf mining specialists.

The biological nature of the book is clearly revealed in Chapter 12, the miner's choice of food. Most of the information in this chapter is entirely new and shows profound development in the study of leaf miners. The list of plant families with the orders of insects known to mine them, gives a broad view of the subject. Of the 148 plant families known from the European and Mediterranean area, only 30 are infested by leaf miners. He stresses the need of the leaf mining specialist (minologist) of having a fundamental knowledge of botany for the

insect species can frequently be identified by the host and the type of mine produced.

The highly specialized habits of leaf miners are pointed out. They live in a habitat of high moisture and temperature and feed upon highly concentrated food. The larva is not confronted by certain plant tissues of little food value as the cuticle. It avoids the green chlorophyll granules, fatty oils, glucocides, alkaloids, etc. Upon their selection of certain types of proteins in plant cells, the author draws many conclusions concerning the relationships of the leaf miners to the geneological tree of plants worked out by Mez 1924, in turn based on serum diagnosis. He explains the selection of widely separated groups of plants such as the Leguminosae and Gramineae or the Rosaceae and the Amentiferae by certain insects on the basis of plant proteins. He suggests that a closer relationship may exist between certain groups of plants than botanists generally recognize. He safeguards himself by stating that "the last word in assessing plant relationships must naturally rest with the scientific botanist."

A detailed discussion of the numerical relationship of plants and miners is given under the headings, Monophagy, Oligophagy, Polyphagy, Pantophagy and Xenophagy.

The chapters on the color and discoloration of mines and the growth changes in mines includes considerable information which he has discussed in previous papers. However, considerable attention is paid to the coloration of mines. Discoloration is more common and usually results from dead tissues. He describes colors varying from white and yellow,through various shades of green to brown and black. More brilliant colors may occur from blue to purple and red. Detailed information is given to explain the production of these colors. Especially interesting are the green areas or islands of color preserved by some species even after the normal autumnal discoloration.

The miners of aquatic plants are carefully summarized including those mining in leaves above the water, those mining in floating leaves, those mining in submerged leaves and those with truly aquatic habits.

In closing he gives a discussion of methods of studying leaf miners with suggestions on collecting and breeding leaf miners and arranging material for the collection.—S. W. Frost.

ECOLOGICAL ANIMAL GEOGRAPHY, (2nd ed.), by W. C. Allee and Karl P. Schmidt. An authorized edition, rewritten and revised, based on *Tiergeographie auf oekologischer Grundlage*, by the late Richard Hesse. ix+715 pp. John Wiley and Sons, New York, 1951. Price $9.50.

Ecological Animal Geography has been, since its publication in German in 1924, one of the fairly few books of real quality and distinction in the field. Available to English readers in a translation by W. C. Allee and K. P. Schmidt since 1937, this valuable work is now brought up to date in a new revision by these authors.

The first of the four parts of the book is a general discussion of ecological and biogeographic principles. Characteristics of the field of animal geography, its distinctive problems and approaches and its relation to other fields are described. Environmental conditions affecting the life of animals and their distributions are discussed, and the progressive impoverishment of fauna with increasingly rigorous environmental conditions demonstrated. Three major types of environments—marine, fresh-water, and terrestrial—and three major living communities or biocycles corresponding to these, are recognized, and the adaptations necessary for marine animals to leave the ocean and occupy fresh water and land environments considered. Three chapters are devoted to three of the familiar topics of biogeography: barriers and their significance and the means of dispersal tending to bridge them; effects of geographic isolation; and historical factors, land bridges, and possible continental movements affecting distributions. A discussion of the influence of extent of range completes the treatment of ecological principles.

The remaining three parts of the book describe animal communities of the world, one of them dealing with each of the three major community groupings. In each of these environmental conditions and adaptations necessary for meeting

them are discussed and the communities and their fauna described. One detail here, the authors' continued identification of the term "niche" with "habitat" and "biotope" seems unfortunate. Broadly conceived and scholarly, these descriptive sections are natural history in the best sense. There are other descriptions of animal communities in general available, but to the reviewer's mind Hesse's is the best.

Although described by Allee and Schmidt as an essentially new work resulting from fourteen years' accumulated changes beyond the first English edition, it is not fundamentally different from the original. It is still Dr. Hesse's book, brought up to date; and this is no criticism considering the quality of the original. The changes in the new edition are in details—a new paragraph here, a sentence or clause added or changed to provide for new citations and changing interpretations, there. The most conspicuous change in the book is its lengthening by 118 pages, the greater part of which, however, results from expansion of the literature lists. In these the previously abbreviated citations have been replaced by full ones alphabetically arranged and including the titles of papers, a considerable improvement. The increase in number of titles in the total bibliography amounts to only four to five percent although, since some older citations have been dropped and replaced by newer ones, the amount of new material brought into the present edition is greater than this would indicate. The new edition is printed on higher quality paper than the old. The increase in price is sufficient to make a book which was formerly reasonably priced for one of the texts in the reviewer's animal ecology course an expensive volume for students. It might be wished that quality of some of the figures had been improved along with that of the paper on which they are printed.

Insects are mentioned in various places through the book, but only incidentally, in the illustration of principles and description of communities. The book has value to an entomologist primarily as a background reference on biogeographic principles applying to insects as to other animals, rather than for the limited material on insects in it. Any biologist referring to the book is likely to find it good reading; the authors have done very well indeed at presenting a large amount of material in a concise but readable and unpedantic style. Because of this and the wealth of material in it, *Ecological Animal Geography* is one of those few scientific treatises or texts which even someone who has studied it before and perhaps used it as a text can read again with interest and pleasure.

—R. H. WHITTAKER.

GRUNDZUEGE EINER THEORIE DER PHYLOGENETISCHEN SYSTEMATIK, by DR. WILLI HENNIG. viii+370 pages, paper bound, 58 text figures. Deutsches Entomologisches Institut, Berlin-Friedrichshagen. 1950. Price, 25.–DM.

It was not so long ago that a good knowledge of German was considered an indispensable part of a taxonomist's training. That is hardly true now, although any taxonomist, at least in entomology, soon finds that it should be. Dr. Hennig's book is in some ways unique. It is the first work dealing with the broader foundations of taxonomy written from an entomologist's viewpoint. Any biologist who is at all concerned with the problems of taxonomy and phylogenetics will find his work in reading it well repaid.

The subject is dealt with in a very different manner than in Huxley et al. (The New Systematics), Mayr (Systematics and the Origin of Species), or Cain (Foundations of Plant Geography), to mention a few of the recent works which are better known in this country. Hennig examines the roots of the subject, and therein, it seems to me, lies the chief value of his work. He divides his subject as follows: I. The Position of Systematics within the Framework of the Biological Sciences (35 pages); II. Tasks and Methods of Taxonomy, a) in the Realm of Group Categories of Lower Rank, and b) in the Realm of Higher Categories (225 pages); III. Problems, Tasks, and Methods of Phylogenetics (Nomothetic Tasks of Systematics) (70 pages).

A bibliography of 241 titles is appended, mostly referring to papers in German. Somewhat less than 14% are titles in English. Compared to the bibliographies of Mayr (451 titles, 63% in English) and Cain (720 titles, 80% in English), this is a

sad commentary on the international nature of biological science. Hennig has informed me (per litt.) that his work was written under very difficult conditions during World War II while he was a "Sanitätsoffizier" in Italy. He enlarged the bibliography in the winter of 1945, but owing to the "unavailability and destruction of the great German libraries" it was largely by reference to his own notes and library. Therefore, he says, "the literature is naturally cited somewhat one-sidedly and some important new works are not referred to."

A new "preliminary" definition of the species (p. 39) is interesting. Done in English, it is: *In a hierarchically constructed phylogenetic system, the highest of those group categories in which all member semaphoronts are bound to each other by autogenetic relationships*. A considerable part of the second section of the work is taken up with the explanation and amplification of this cautious statement.

Also interesting are remarks in the chapter on the relative rank of the higher categories. Gauss is quoted as having said, "I have the result, but I don't know yet by which means I shall arrive at it" and Michaelis is quoted: "Integration is . . . an art . . . wherein one often has the task of extracting (*herauszukombinieren*) those manipulations, out of the numerous ones within the realm of possibility, which will make the solution of the problem possible." Hennig then says, "That is exactly the position in which the phylogenetic systematist finds himself. He also has available for the solution of his "integration problem" exact, scientific methods, the discussion of which occupies a considerable part of the present work. When he, in order to determine which one of these methods might make possible the solution of a certain problem, has to depend upon properties which do not lie in the realm of the learnable, he is just as little to be blamed as the mathematician who finds himself in a similar position."

The book is obtainable only from the Deutsches Entomologisches Institut, Berlin-Friedrichshagen (Russian Zone), Waldowstrasse 1, for the equivalent of 25.-DM. It is also gladly furnished in exchange for other entomological literature.

—GEORGE C. STEYSKAL.

REVISTA CHILENA DE ENTOMOLOGÍA. Published by the Universidad de Chile and the Sociedad Chilena de Entomología, Santiago, Chile.

The first volume (1951) of this new journal appeared under the date of December 27, 1951. Its 288 pages are devoted to sixteen original articles, historical material on Claudio Gay and Rodulfo Amando Philippi, short notes, and indexes. The original articles are written by C. P. Alexander, J. Bechyné, J. M. Bosq, R. Cortés, F. I. van Emden, R. Gutiérrez, G. Kuschel, F. Monros, C. W. Sabrosky, K. E. Schedl, P. Vaurie, E. Voss, W. Wittmer, and P. Wygodzinsky. The historical material is, quite fittingly, an account written by Claudio Gay in 1832 of his scientific exploration of Chile.

It is encouraging to see a publication of this type from a country which has been coming to the fore in the entomological world and which is needing just such an outlet for the publication of her research in this field. The Revista Chilena is well edited, well printed, and in its first volume, has published substantial and important articles. Congratulations to its editors and sponsoring society.—M. T. J.

INSECTS AS HUMAN FOOD. A CHAPTER OF THE ECOLOGY OF MAN, by F. S. BODENHEIMER. 352 pages, 47 illustrations. Dr. W. Junk, Publishers, The Hague, 1951.

This intriguing book deals with a subject of interest to the general public and will undoubtedly be read more widely than other books treating insects from a different viewpoint. For this reason a short glossary of words such as elytra, aposematic, cryptic, pupae, larvae, and others, might have been added.

The book brings together much interesting material on the use of insects as food by peoples throughout the world. It not only gives the "history of entomophagy" (the eating of insects) from prehistoric times up to the present but gives the insect eating habits of people throughout the world today, and of recent times.

The author has taken all the available material on "entomophagy" and presents it as practiced in each of the continents of the world. He first discusses

the use of insects as food by the various primitive peoples of Australia and nearby islands. He next takes Africa, then Asia, and lastly the Americas. A number of interesting native superstitions and legends are noted in connection with entomophagous habits. In Australia where the lerp manna of psyllids is used as food by some of the native tribes there is the belief that when the manna is plentiful a great drought will follow. Certain tribes of Morocco, Africa, believe that if earth, taken from a place where three roads meet, is thrown over bees it will keep them in good condition and they will have more honey. In Assam, it is believed that the spirits of men become honey-bees. Indians at Cuernavaca, Morelos, Mexico, believe that eating pentatomid bugs will cure liver, stomach and kidney complaints, and rheumatism.

In the various countries the native peoples have developed methods of capturing insects and preparing them either for immediate use or for keeping them for future use.

The author, in his zeal to give credit to his various sources of information, has so organized his subject matter that the reader finds repetitious material several pages apart, or is not sure whether the statement being read at the moment is that of the author or of the source he has just quoted.

The chapter on "The Nutritive Value of Insects as Human Food" was of especial interest to the reviewer. Termites are said to contain more protein and calories than the same amount of beef or dried salt-fish!—LUELLA M. WALKLEY.

THE FALSE SPIDER MITES OF CALIFORNIA (ACARINA: PHYTOPTIPALPIDAE), by A. EARL PRITCHARD and EDWARD W. BAKER. Univ. Calif. Pub. Ent. 9 (1): 1–94, 45 figs. 1951. Price, $1.00.

A GENERIC REVISION OF THE FAMILY AGROMYZIDAE (DIPTERA) WITH A CATALOGUE OF NEW WORLD SPECIES, by KENNETH FRICK. Univ. Calif. Pub. Ent. 8 (8): 339–452, 32 figs. Price, $1.25.

THE HELEIDAE OF CALIFORNIA, by WILLIS W. WIRTH. Univ. Calif. Pub. Ent. 9 (2): 95–266, 33 figs. Price, $2.00.

These three monographs represent important contributions to the taxonomy of the economically important and insufficiently known groups with which they deal. All three show evidence of scholarly work and careful preparation, with good illustrations which are, apparently adequate for their needs. Drs. Pritchard and Baker have entered a little worked field; twenty-four of the forty California false spider mites are described as new. Dr. Frick, by a study of Old and New World forms alike, has presented a classification of a difficult and economically important family, which seems to be much more nearly natural than previous classifications based largely on studies of restricted faunas. Dr. Wirth's treatment of the California Heleidae, with consideration of both larval and adult forms, seems to be an excellent and thorough study of this family. The three monographs are quite worthy of the efforts of the staff and graduate school of a great university.—M. T. J.

PATHOLOGY IN FOREST PRACTICE, by DOW VAWTER BAXTER. Second Edition. xiii+601 pages, 224 figs. + frontispiece. John Wiley and Sons, New York. 1952. Price, $7.50.

This work deals with viral and plant pests (chiefly Fungi) of forest trees and wood products; the insect enemies have been adequately treated in other text books and monographs. Nevertheless, it will interest the student or teacher of forest entomology, in that it contains some material of entomological interest. The chief reason for inclusion of such material is the role that insects play in the transmission of tree diseases, particularly Dutch elm disease, phloem necrosis of elms, and blue strain of conifers. A second reason for such inclusion lies in the fact that insect and plant pest infestations may, in their effects, modify each other. The number of references to insects in the index, under both general headings and those dealing with specific groups of pests, is rather surprising.—M. T. J.

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Papers should ordinarily be submitted directly to the Editor. However, they may be submitted to any member of the Editorial Board, especially where such member is particularly qualified in the subject matter of the paper.

Any illustrated manuscripts submitted must be accompanied by finished illustrations which are ready for reproduction (or by engravings plus proof if the author prefers to have his own made). The price of zinc cuts or half-tone engravings in excess of one page of cuts for each twelve pages of printed matter will be charged to the author at cost. It is to be noted that text, tables, zinc cuts and half-tone engravings are all printed alike on one quality of paper at the standard 4¼ x 6¾ inch size. If an author has tabular material or illustrations that require another size or a special paper, such is obtainable only by special arrangement with the editor and at the expense of the author.

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